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WATER DISTRIBUTION SYSTEM AS A POTENTIAL SOURCE OF MUTAGENS IN DRINKING WATER

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16. ABSTRACT

The primary objective of this study was to examine the changes in concentration of 6 PAHs and the possibility of changes in mutagenic potential of treated waters as a result of leaching during their passage through commonly used distribution pipes in the U.S. With the exception of Wheeling, WV treated water, which showed an unusually high total polycyclic aromatic hydrocarbon concentration of 138.5 ppt, the total polycyclic aromatic hydrocarbon concentration in all other treated water ranged from 0 to 13.4 ppt. The corresponding total polycyclic aromatic hydrocarbon concentration in water after their passage through the distribution pipes varied from 0 to 61.6 ppt. This indicates a small increase of polycyclic aromatic hydrocarbon concentration in waters as a result of their passage through the asphalt-lined distribution pipes.

Mutagenic activity was also detected in many of the water samples treated, however, the levels of this activity did not correlate with either the transit of water through the distribution system or the levels of polycyclic aromatic hydrocarbon in the water. There was some evidence to indicate that the water treatment process itself may have contributed to the mutagenicity observed in the finished water and that compounds responsible for the observed activity were different from the low molecular weight chlorinated compounds produced during chlorination.

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FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

The complexities of the environmental problems originate in the deep interdependent relationships between the various physical and biological segments of man's natural and social world. Solutions to these environmental problems require an integrated program of research and development using input from a number of disciplines. The Health Effect Research Laboratory conducts a coordinated environmental health research program in inhalation toxicology, genetic toxicology, neurotoxicology, developmental and experimental biology and clinical studies using human volunteer subjects. These studies address problems in air pollution, water pollution, non-ionizing radiation, environmental carcinogenesis and the toxicology of pesticides and other chemical pollutants. The Laboratory participates in and provides data for the development and revision of criteria documents on pollutants for which national ambient air quality and water quality standards exist or are proposed, provides the data for registration of new pesticides or proposed suspension of those already in use, conducts research on hazardous and toxic materials, and is primarily responsible for providing the health basis for non-ionizing radiation standards. Direct support to the regulatory function of the Agency is provided in the form of expert testimony and preparation of affidavits as well as expert advice to the Administrator to assure the adequacy of environmental regulatory decisions involving the protection of the health and welfare of all U.S. inhabitants.

The storage tanks and pipes through which drinking water passes from the treatment plant to the consumers are coated with a variety of protective materials including epoxy, coal tar and asphalt based enamels. This report is an assessment of the potential for polynuclear aromatic hydrocarbons or mutagenic materials to be leached from these coatings as the water passes through the distribution system.

F. Gordon Hueter, Ph.D., Director
Health Effects Research Laboratory

ABSTRACT

The primary objective of this study was to examine the changes in polycyclic aromatic hydrocarbon concentrations and the possibility of changes in mutagenic potential of treated waters as a result of leaching during their passage through commonly used distribution pipes in the U.S. A method developed in our laboratories was used for the collection and analysis of water samples for polycyclic aromatic hydrocarbons. The polycyclic aromatic compound benzo(a)pyrene and benzo(ghi)perylene were among the most frequently occurring polycyclic aromatic hydrocarbons in raw and treated water and in waters travelling through the distribution lines. With the exception of Wheeling, WV treated water, which showed an unusually high total polycyclic aromatic hydrocarbon concentration of 138.5 ppt, the total polycyclic aromatic hydrocarbon concentration in all other treated water ranged from 0 to 13.4 ppt. The corresponding total polycyclic aromatic hydrocarbon concentration in water after their passage through the distribution pipes varied from 0 to 61.6 ppt. This indicates a small increase of polycyclic aromatic hydrocarbon concentration in waters as a result of their passage through the asphalt-lined distribution pipes. The increase in polycyclic aromatic hydrocarbon concentration was maximum with recently installed asphalt-lined pipes. Waters from a few distribution lines showed reduction in polycyclic aromatic hydrocarbon concentrations possibly due to sorption of PAH on the surface of these distribution pipes.

Mutagenic activity was also detected in many of the water samples treated, however, the levels of this activity did not correlate with either the transit of water through the distribution system or the levels of polycyclic aromatic hydrocarbon in the water. There was some evidence to indicate that the water treatment process itself may have contributed to the mutagenicity observed in the finished water and that compounds responsible for the observed activity were different from the low molecular weight chlorinated compounds produced during chlorination. This study also provides evidence that mutagenic activity is less likely to be found in the raw water supply if this supply is from ground water rather than surface water.

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LIST OF ABBREVIATIONS

BaP	=	benzo(a)pyrene
BghiP	=	benzo(ghi)prylene
BjF	=	benzo(j)fluoranthene
FL	=	fluoranthene
IP	=	indeno(1,2,3-cd)pyrene
PAH	=	polycyclic aromatic hydrocarbons
TLC	=	thin layer chromatography
U.V.	=	ultra violet

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SECTION 1

INTRODUCTION

The presence of trihalomethanes and other potentially carcinogenic compounds in drinking waters has caused considerable public concern over the potential effects on health arising from the consumption of these waters. The two generally recognized sources of chemical contamination of drinking water are pollutants present in raw water sources of potable waters and compounds formed during treatment of raw water, such as chlorination of finished waters. A third and little investigated source is the possibility of contribution of mutagenic or carcinogenic substances in drinking waters by the pipes used in the distribution of potable waters. The level of exposure to chemicals through the consumption of pipe-leachable compounds in potable waters may be low but of long-term duration. In the absence of a general agreement that a completely safe exposure level of biologically active chemicals does exist, it is important to identify the suspected chemicals and evaluate the possible health effects associated with the use of potable waters after their passage through the distribution pipes.

German workers have shown that significant amounts of polynuclear aromatic hydrocarbons (PAH), many of which are suspected or proven carcinogens, can be added in the distribution system (Borneff, 1977). In one case, the concentration of PAH at the end of the water supply network was about 10 times higher than the concentration at the treatment site. Small increases in the concentration of six PAHs at the end of the supply network are also indicated from our preliminary investigation on three water supplies within the United States; the asphalt-based coating material used within the pipes was suspected to be the cause of this problem. Microbial mutagenicity assays utilizing histidine dependent strains of S. typhimurium (Ames et al., 1973) were also performed on drinking waters obtained from the distribution system at three selected water supplies. The results revealed a significant increase in the mutagenic activity upon passage of the treated water through distribution pipes. Some of the compounds introduced required mammalian metabolic activation (i.e., S-9 mix), whereas others elicited mutagenic responses without the activation system.

The present investigation is directed at examining the contribution of mutagenic compounds from the supply network to selected water supplies within the United States. The overall mutagenic potential will be assessed by utilizing non-specific bioassay systems. Furthermore, in view of the potential of the distribution pipes for addition of PAH, the presence of PAH in these waters will also be examined.

The study proposed is a screening type investigation and is designed to provide information concerning the intensity and frequency of the problem with water distribution processes. The results of this investigation will be helpful to EPA in setting priorities for in-depth and more specialized work, and in the epidemiological investigation completed by EPA to derive a relationship, if any, between the quality of drinking water and the occurrence of certain types of cancer.

SECTION 2

CONCLUSIONS

The primary objective of this study was to investigate the possibility of enhancement of PAH concentration and mutagenicity of treated water as a result of its passage through distribution pipes. The results indicate that in 67% of the total water supplies studied, a measurable increase in PAH concentration in water does occur as a consequence of treated water travelling through petroleum asphalt-lined distribution lines. The increases in PAH concentration, however, were small and amounted to a maximum of 61 ppt in water. It was also determined that the maximum leaching effect occurred with distribution pipes that had recently been coated with asphalt linings. The recently installed asphalt-coated pipes predominantly added the more water-soluble PAH, whereas the older pipes predominantly leached the less water-soluble PAH. In older pipes this is probably due to depletion of the more water-soluble PAH from the surface of the lining. Waters from a few distribution lines showed reductions in PAH concentration instead of the expected enhancements of PAH concentration. This reversing trend can be explained by assuming sorption of PAH on the surface of the distribution pipes or chemical interaction with oxidants in water. Distribution pipes that are depleted of the leachable PAH may act as sorbents for these compounds. Thus, depending on the age of the pipes, it is possible to get both desorption and sorption effects. In addition to the pre-selected six PAH identified and quantified in this study, many other compounds were detected in the water samples. No attempt was made to identify these compounds.

The results of bacterial mutagenicity assays (Ames assay) indicated the presence of low levels of mutagenic activity in many of the waters sampled. There appeared to be no correlation between the level of biological activity and the passage of water through distribution pipes. Also there was no apparent correlation between the type of pipe used and the presence or absence of mutagenic activity. The specific compounds that produced the observed mutagenic response were not identified, however, there was no correlation between the PAH levels of water and the observed mutagenicity. In most cases where mutagenic activity was observed in water at the treatment plant this activity was the same or greater than the activity in the raw water. This indicates that the treatment plant was generally ineffective in removing this low level of mutagenic activity, and that some of the processes employed in water treatment may actually contribute to the presence of mutagens in the distribution system. In considering the source of water for potable use, ground waters generally demonstrated less mutagenic activity as compared to surface waters.

SECTION 3

RECOMMENDATION

On the basis of our experience with the present project, we recommend the following areas for further investigations:

(1) Samples that showed mutagenicity should be fractionated to isolate and identify the component(s) responsible for the mutagenic effect.

(2) Since no dramatic PAH leaching was observed with the petroleum asphalt lined pipes, further study should be directed towards the leaching effects from coal tar-based distribution pipes. It is expected that the leaching may be more dramatic with these pipes than asphalt based distribution pipes.

(3) In the present investigation, the age of the installed pipes was found to be one of the most critical factors in the leachability of PAH from the pipe linings. In future studies, the age of pipes, condition of coating, and contact time should be given one of the primary considerations in the selection of sampling sites. Recently installed pipes are expected to provide more dramatic enhancement of PAH concentraton than the older pipes.

(4) Factors, such as pH, residual chlorine, aggressive index of water and conditioning of the pipes after application of coatings--all the factors that may affect the leaching of PAH-- should be more thoroughly studied.

(5) The effect of chlorination of drinking water on some of the leached compounds should be investigated. A few recent investigations suggest that the leached compounds are susceptible to the formation of chlorinated or other oxidized products in the presence of chlorine.

(6) The apparent increase in mutagenic activity resulting from conventional water treatment processes should be studied in greater detail. This should include an investigation of the production of high molecular weight compounds having biological activity as a result chlorination.

(7) The mutagenic activity of trace contaminants in treatment chemicals used for the production of finished water should be investigated as a possible source of mutagenic activity in drinking water.

SECTION 4

LITERATURE REVIEW

The presence of trihalomethanes and other potentially carcinogenic compounds in drinking waters has caused considerable public concern over the potential health effects arising from the consumption of these waters. The two generally recognized sources of chemical contamination of drinking water are pollutants present in the raw water sources of potable waters and compounds formed during treatment of raw water, such as chlorination and ozonation used for disinfecting water prior to human consumption. A third and little investigated source of contamination is the possibility that the pipes used in the distribution of potable waters may contribute mutagenic or carcinogenic substances to drinking waters.

Finished waters from the treatment sites are transported to the consumers through a variety of pipelines. In the United States, three kinds of pipes are commonly used as transmission distribution lines for transporting treated water to consumers: cast iron/ductile iron, abestos/cement, and steel pipes. Other materials occasionally used as water distribution lines are reinforced concrete, a variety of plastic materials, iron, copper, and rarely, lead. Of the total installed length of approximately 685,000 miles of water distribution lines in the United States, about 75% consists of cast iron/ductile iron pipes, 13% consists of asbestos/cement pipes, and 6% consists of steel pipes (Goldfarb et al., 1979).

With the exception of plastic pipes, coating materials are often used for the interior of the water pipes to prevent corrosion or to aid in curing the pipes. For example, cast iron/ductile iron pipes are sometimes lined with asphalt, cement, or asbestos/cement coatings; concrete pipes with asphalt coatings; and steel pipes with cement or coal-tar coatings (Goldfarb et al., 1979). Depending upon the characteristics, manufacturing conditions, thickness, and age of the pipe or its lining, some leaching of materials can be expected to occur as water passes through the pipes. McFarren et al. (1977) have demonstrated that galvanized iron pipes may leach into drinking water, lead, zinc, and cadmium; asbestos/cement pipes some asbestos fibers; and PVC pipes some residual vinyl chloride. The leaching of volatile organic compounds from different types of water pipes has also been studied in Europe (Eklund et al., 1978). Cast iron pipes coated with polyurethane have been shown to add volatile contaminants such as chlorobenzene and aromatic compounds in drinking waters.

Both asphalt and coal-tar are known to contain high levels of polycyclic aromatic hydrocarbons (PAH), some of which are known or suspected carcinogens, although the level of PAH in coal tar may be 1000 to 100,000 times higher than in asphalt. Table 1 presents the levels of a few PAH in coal-tar and petroleum asphalt as determined by Radding et al. (1975).

Table 1. Levels of Some PAH in Fossil Fuel Derivatives (Radding et al., 1975)

PAH Identified	PAH Content in Fossil Fuel Derivatives, µg/g		
	Coal-Tar	Coal-Tar Pitch	Petroleum Asphalt
Benzo(a)pyrene	30,000	12,500	0.1-27.
Chrysene	up to 2,860	up to 10,000	0.4-34.
Benzo(a)anthracene	up to 6,980	up to 12,500	up to 34.

It is thus possible that the coating of coal tar-based or asphalt-based paint or sealant on iron, steel or concrete pipes could cause leaching of small amounts of PAH into drinking water, determined partly by selective solubilitation of the PAH's as a function of solubility. Borneff (1976) reported a ten-fold increase in PAH concentration at the end of water supply pipes resulting from the coating used inside the water pipes. In a study in Pascagoula, Mississippi, more than 9 PAH, including fluoranthene at concentration as high as 9.7 ≈g/l, were reported in water stored in a tank freshly coated with coal-tar pitch (McClanahan, 1979). Similarly, potable water obtained from a terminal point of a water distribution pipe coated with coal-tar showed the presence of PAH. The fluoranthene and phenanthrene concentrations in this Portland, Oregon, water were reported to be 0.6 µg/l and 3.2 µg/l, respectively (Roebeck, 1979).

Although the leaching of coating materials from the pipes can account for the presence of many compounds including PAH, it may not be the only mechanism which could contribute to the deterioration of the water quality resulting from passage of drinking waters through supply networks. The reaction of residual chlorine with organics leached from pipes, oxidation of leached materials, or microbiological synthesis of compounds on pipe walls and their subsequent release into the water may cause contamination of the water with compounds not originally present in the finished waters.

The examination of changes in water quality resulting from distribution pipes can be accomplished by determining changes in the levels of specific chemicals. Because of their reported presence in some coating materials used inside the distribution lines, and because of the known carcinogenic potential of many of the compounds in this class, PAH were chosen as a class of chemicals to be monitored in order to determine possible adverse effects of the distribution system on water quality. To monitor the effects of other harmful compounds that may be leached from the pipes or produced in the distribution system, an assay was also employed that was not specific for a particular class of chemicals.

This general assay was an *in vitro* microbiological mutagenicity assay which has the capability of detecting a large variety of compounds with genotoxic potential. Therefore, the present investigation was primarily oriented to provide information on two aspects of water quality: PAH content and the presence of mutagens in drinking waters as a result of passage of those waters through the distribution pipes.

The monitoring of the expected low levels of PAH in drinking waters required the selection of a method (Basu and Saxena, 1978a) that was capable of concentrating PAH from large volumes of water. The method must also include a chemical separation procedure capable of eliminating interfering impurities, and a quantification method sensitive enough to detect small amounts of PAH. A method developed in a previous study (Basu and Saxena, 1978b) was found to be suitable and was used for the monitoring of PAH levels in waters.

The overall mutagenic potential was assessed by utilizing the Ames *Salmonella* assay system. This assay employs a mammalian metabolic activation system, thus allowing the detection of compounds that are biologically active only after having been metabolized. The system was chosen primarily for two reasons. First, it provides a quick screening method for testing mutagenic potential of compounds. Second, a high correlation between positive results in the Ames assay and positive results in *in vivo* animal carcinogenicity assays has been established for a large number of compounds (Ames *et al.*, 1973; McCann *et al.*, 1975).

SECTION 5

MATERIALS AND METHODS

MATERIALS

PAH Standards

Fluoranthane, Benzo(ghi)perylene, Indeno-(1,2,3-cd)pyrene, and Benzo(a)-pyrene were obtained from Aldrich Chemical Co. Each compound was at least 99% pure as verified by GC-FID and TLC-fluorimetric analysis. Benzo(j)- and Benzo(k)fluoranthene were obtained from Community Bureau of Reference (BCR), Brussels, Belgium. These were certified reference materials of better than 99% purity and used as received.

Materials for Capillary Column (WCOT) Chromatographic Analysis

Gases: He (carrier gas) was of ultrahigh purity grade, N_2 (detector make-up gas) and H_2 were both prepurified medical grade, Linde Division, Union Carbide Corp.

Aluminum foil-backed septa(Metasep) were from Altech Associates

WCOT Columns were 30 m x 0.25 mm i.d. and 15 m x 0.25 mm i.d., and both were coated with SE-54 obtained from Supelco, Inc. Analysis of samples collected after 8-1-80 were performed with the shorter column. The gas chromatograph with dual flame ionization detector was a Hewlett-Packard Model 5730A with 18740B capillary column control accessories, operated in the splitless mode, and used with a Fisher Recordall Series 5000.

Materials for Thin Layer Chromatography

Acetylated cellulose (40%), aluminum oxide G (type E), 8 x 8 cm glass plates, TLC tank, Desaga template, and Desaga-Brinkman Spreader were obtained from Brinkman Instrument, Inc. Spectrophotofluorimeter with thin film scanner was from American Instrument Co., and the U.V. Lamp (Mineralight) for visualization of TLC spots was from Scientific Products, Inc.

Materials for Radiolabeling Work

Radiolabeled 7, 10 ^{14}C-benzo(a)pyrene was obtained from California Bionuclear Corp. and a Packard Tri-Carb Scintillation Spectrometer with Teletype Printer was used for determination of radioactivity. Scintillation fluid contained 2,5-diphenyloxazole (PPO), 2,2'-phenylene bis-(5-phenyl) oxazole (POPOP) which was purchased from Packard Instrument Co.

Materials for Sampling

Cyclindrical flexible polyurethane foam tube or flask plugs (45 mm x 45 mm) with a trade name of "Identi-Plug" were obtained from VWR Scientific Co. Extender type chromaflex columns of 25 mm i.d. with "O" rings, adapters and clamps were from Kontes Glass Co. The Masterflex pump, controller and pumpheads were made by Cole-Parmer Instrument Co., Chicago, and the Haake Model FE Thermostated Circulator with 1000 W Heater was purchased from VWR Scientific Co.

Chemicals, Reagents and Apparatus for Sample Treatment

All solvents were from Burdick Jackson Lab., Inc. and distilled in glass. Chromatographic grade Florisil (60-100 mesh), was obtained from Floridin Co.

The Buchler Rotary Vacuum evaporator with thermo-regulator and immersion heater was purchased from Scientific Products, Inc. and calibrated tubes (6.5 ml), with each of the last four-tenth ml calibrated to one-hundredth ml were purchased from Fisher Scientific Co.

Standard PAH Solution

Stock solutions of each of the six PAH were prepared by dissolving 100 mg in 100 ml benzene in a volumetric flask (1000 ppm).

In order to prepare working PAH standard mixtures for GC analysis, 1 ml each of the six stock solutions were diluted in a 10 ml volumetric flask and brought up to the final volume with benzene (100 ppm). Standard PAH mixture for TLC was prepared by mixing 5 ml of the standard (100 ppm) fluoranthene solution and 1 ml each of the five other PAH (100 ppm) in a glass stoppered bottle, (final concentration: 50 ppm fluoranthene, 10 ppm others).

Materials for Bioassays

Test organisms utilized in the mutagenicity bioassays were specially constructed strains of Salmonella typhimurium designated TA98, TA100, TA1535, TA1537, and TA1538, all supplied by Dr. Bruce Ames (Berkeley, California). During the course of the study it was necessary to obtain subcultures of S. typhimurium strains TA100 and TA98 from Dr. Edmond J. LaVoie at the American Health Foundation. Male Sprague-Dawley rats weighing 150-200 gm each were obtained from a commerical supplier, Taconic Farms, Inc. (Germantown, NY) and were used in the preparation of liver homogenates for the S-9 metabolic activation system.

DIFCO Bacto-Agar and DIFCO Nutrient Broth (Scientific Products) were used for media preparations. Aroclor 1254 (Monsanto Co.) and U.S.P. corn oil (Fisher Scientific) were used in the induction of rat liver enzymes. Diagnostic mutagens routinely used for positive controls were: 4-nitro-o-phenylenediamine (Sigma Chemical), methylmethane sulfonate (Aldrich Chemical), 9-aminoacridine (Sigma Chemical), 2-aminoanthracene (Sigma Chemical). The DMSO (dimethyl sulfoxide) was obtained from Burdick and Jackson Laboratories. All salts, and other chemicals were of reagent grade.

Unconcentrated water samples were filter sterilized using a 90 mm standing filter holder (Millipore Corporation), with 90 mm Gelman filters (0.20 μm, 0.45 μm, 1.20 μm, and glass prefilters). Revertant colonies were counted with a BioTran II automatic colony counter.

EXPERIMENTAL PROCEDURES

Sampling Procedures

Selection of Sampling Sites--

The sampling locations for this study represent the largest water supplies within the 24 selected counties in the United States. The counties were selected by the U.S. Environmental Protection Agency for an epidemiological study of association between cancer mortality rates and drinking water quality. Twelve pairs of counties were selected with contrasting (high and low) total mortality rates for colon, rectum, bladder, and liver cancer in females during the years 1968 to 1974. Each pair of counties was matched on the basis of five demographic characteristics (geographic region, total population, percent urbanization, median school years completed, and percent of work force in manufacturing industry). Only counties which were at least 50% urban were included. The present investigation was intended to provide an additional parameter, PAH, for correlation with EPA's epidemiological data. Table 2 identifies the raw water source, type of raw water pollution, treatment provided to generate finished water, and the date of sampling for the water supplies investigated in this study.

Sampling Procedure

Earlier studies (Basu and Saxena, 1978b; Saxena et al., 1977a; Saxena et al., 1977b) showed that water passing through foam plugs at 62 ± 2°C at a flow rate of 250 ± 10 ml/min can effectively concentrate PAH from water. Four foam plugs two in each column and connected in series, were adequate for sampling 20 liters of finished water and 10 liters of polluted raw water. A maximum volume of 75 liters of finished water and 60 liters of raw water were sampled with a portable sampling unit assembled in our laboratory from a combination of off-the-shelf hardware available commercially.

With a minor modification, the sampling unit described in our earlier work (Basu and Saxena, 1978a) was employed for the collection of water samples in the field. To facilitate air transportation, the components of the sampling equipment were assembled inside suitcases. The overall unit consisted of the following five parts: (a) variable water pumping unit consisting of a Masterflex pump with appropriate pump heads and flow controller, (b) Haake Thermostated Water Circulator, (c) unit containing the column systems, (d) thermometer, and (e) flowmeter.

The variable pumping unit allowed water from the sample source to be pumped to a column system (containing the foam plugs) at a controlled rate of 250 ± 10 ml/min. The water prior to reaching the column passes through the stainless steel coil of a Haake heating bath and was maintained at 62 ± 2°C. The column system consisted of two 25 mm i.d. Chromaflex extender-type columns connected in series with the help of tapered glass adaptors and double-bent pyrex tubing. The temperature of the water passing through the columns was monitored by introducing

Table 2. Some Characteristics of the Water Supply Systems Used for Sampling

Supply System	Raw Water Source	Type of Pollution	Treatment[a] Provided	Dates Sampled
Appleton Water Department, Outagamie County Appleton, Wisconsin	Lake Winnebago	Paper mill wastes	Activated carbon, lime, alum, ferric sulfate ammonium sulfate addition, filtration, chlorination, and fluoridation	3-13-78 to 3-14-78
City of Augusta Water Department, Richmond County, Augusta, Georgia	Savannah River	May contain some wastewater	Alum, lime, filtration, chlorination, and fluoridation	5-7-79 to 5-9-79
City of Austin Water Treatment Plant, Travis County, Austin, Texas	Colorado River at Town Lake	Polluted water	Lime, soda ash, ferric sulfate, ammonia, calgon, activated carbon addition, filtration, chlorination, and fluoridation	11-12-79 to 11-14-79
City of Billings Water Works, Yellowstone County, Billings, Montana	Yellowstone River	River receives treated waste water from meat packing industry and sanitary sewage.	Alum, $KMnO_4$, $CaSO_4$, activated carbon, ammonia, Na-Zn-hexametaphosphate addition, filtration, and chlorination	6-24-80 to 6-25-80
Northern Illinois Water Corp., Champaign County Champaign, Illinois	Ground Water	No known source of pollution	Lime, ferric sulfate sulfuric acid addition, chlorination and fluoridation	3-16-78 to 3-18-78 and 6-22-81 to 6-23-81
City of Eau Clair Water Department, Eau Clair County, Eau Clair, Wisconsin	Ground Water	No known source of pollution	Silicate and lime addition, sand filtration, chlorination and fluoridation	7-16-79 to 7-18-79

(continued)

Table 2. (Continued)

Supply System	Raw Water Source	Type of Pollution	Treatment[a] Provided	Dates Sampled
Elkhart Water Works Elkhart County, Elkhart, Indiana	Ground Water	No known source of pollution	Filtration, chlorination, and fluoridation	9-19-77 to 9-20-77 and 6-19-81 to 6-20-81
Fairborn Water Treatment Plant, Green County, Fairborn, Ohio	Ground Water	No known source of pollution	Aeration, filtration, and chlorination	10-17-77 to 10-18-77 and 4-23-81 to 4-24-81
P.O. Hoffer Water Plant, Public Works Commission Cumberland County, Fayetteville, North Carolina	Cape Fear River	No known pollution source	Alum, NaOH, phosphate, activated carbon addition, filtration, chlorination and fluoridation	12-19-80 to 12-20-80
Fond Du Lac Water Department, Fond Du Lac County, Fond Du Lac, Wisconsin	Ground Water	No known source of pollution	Phosphate addition, filtration, chlorination and fluoridation	9-26-79 to 9-28-79
Kenton County Water District No. 1, Kenton County, Ft. Mitchell, Kentucky	Licking River at Ohio River	Less polluted water than Ohio River water	Alum, lime addition, filtration, chlorination and fluoridation	12-16-80 to 12-17-80
Lee County Water Treatment Plant, Lee County, Ft. Myers, Florida	Caloosahatche River	Contains a dense population of algae	Alum, lime, activated carbon addition, GAC filtration, chlorination and fluoridation	5-14-79 to 5-19-79 and 8-11-81 to 8-12-81

(Continued)

Table 2. (Continued)

Supply System	Raw Water Source	Type of Pollution	Treatment[a] Provided	Dates Sampled
Fremont Filtration Plant, Sandusky County Fremont, Ohio	Sandusky River	Contaminated with treated municipal wastes and agricultural wastes	$KMnO_4$, $Ca(OH)_2$,[b] NaOH, Na-aluminate, CO_2 addition, filtration, chlorination and fluoridation	8-25-77 to 8-28-77 and 4-20-81 to 4-21-81
City of Hutchinson Water Department, Reno County, Hutchinson, Kansas	Ground Water	No known pollution source. Scattered salt mines near ground wells	Only chlorination	5-9-80 to 5-11-80
Iowa City Water Department Johnson County, Iowa City, Iowa	95% Iowa River and 5% ground water	No industrial wastes. May contain washouts from agricultural lands.	Alum, lime, activated carbon addition, filtration, and chlorination	10-1-79 to 10-2-79
La Crosse Water Utility La Crosse County La Crosse, Wisconsin	Ground Water	No known source of pollution	Only chlorination	7-12-79 to 7-14-79
City of Merced Water Department, Merced County, Merced, California	Ground Water	No known pollution source	Only fluoridation	10-14-80 to 10-15-80
City of Nampa Water Department, Canyon County, Nampa, Idaho	Ground Water	No known pollution source	Only chlorination	6-27-80 to 6-29-80
City of San Luis Obispo Water Department, San Luis Obispo County, San Luis Obispo, California	Santa Margereta Lake	No known pollution source	Alum, soda ash addition filtration, chlorination and fluoridation	10-17-80 to 10-18-80

(Continued)

Table 2. (Continued)

Supply System	Raw Water Source	Type of Pollution	Treatment[a] Provided	Dates Sampled
City of Olympia Water Department, Thurston County, Olympia, Washington	Artesian Wells	No known pollution source	Only chlorination	8-22-80 to 8-23-80
E. Love Filtration Plant, Tuscaloosa Water Works, Tuscaloosa County, Tuscaloosa, Alabama	North River	No known pollution source	Lime, $KMnO_4$, alum addition, filtration, chlorination and fluoridation	5-5-80 to 5-7-80
Wheeling Water Treatment Plant, Ohio County Wheeling, West Virginia	Ohio River	Industrial and domestic wastes	Aeration with lime and ferric sulfate, phosphate, activated carbon addition, filtration, chlorination and fluoridation	2-2-78 to 2-4-78
Jasper Water Treatment Plant, Wichita County Wichita Falls, Texas	Lake Kickapoo and Lake Arrowhead	Both lakes are surrounded by a number of oil fields. Pollution from oil fields a possibility. Also contains algae.	Lime, ferric sulfate addition, filtration chlorination and fluoridation	11-17-79 to 11-19-79
City of Yakima Water Department, Yakima County, Yakima, Washington	Naches River	No known pollution source	Alum, lime, activated carbon addition, filtration, and chlorination	8-19-80 to 8-20-80

[a]The treatment shown is not necessarily in the proper order, the raw water was treated.

[b]Additional treatments involving the use of ferric sulfate, sodium hexametaphosphate and sodium tripolyphosphate were introduced after the first sampling trip.

a water-trap equipped a thermometer. A Gilmont flowmeter calibrated to measure the flow rate was placed at the end of the sampling unit. The connections were made with glass tubing as much as possible and only where necessary with Tygon tubing.

For convenience of transportation, the variable pumping unit with the flow controller and pump heads was carried in one suitcase and the rest of the unit containing the Haake Thermostated Water Circulator, the clamps for the column system, water trap for the thermometer, and the flowmeter were all fixed in place in another suitcase. The two suitcases were transported to the sampling site along with an electric timer, 20 liter Jerrican and other detachable items such as, extender columns, thermometers, clamps, "O" rings, and connecting tubes. The purpose of the calibrated 20 liter Jerrican was to collect the effluent from the sampling unit and thereby keep an exact record of the volume of water passed through the columns. The timer was used to indicate the running time of the sampler.

At the sampling location, the unit was assembled as shown in Figure 1. Water from a 1 liter beaker placed under a continuously running water tap was pumped through two foam columns under the previously described conditions. Since the residence time for water in the beaker was very short, the losses of PAH due to adsorption were assumed to be insignificant. Both foam columns were changed after a certain volume of water (maximum 25 liters) passed through the columns and the sampling was continued with fresh foam columns. In case of raw water, depending on the suspended solid content, this maximum volume varied from 10 liters to as high as 20 liters. After sampling the desired volume of water, the columns were wrapped in aluminum foil, cooled in ice, and transported to the laboratory. In the laboratory, a major part of the foam eluate obtained by solvent extraction was used for PAH analysis and a fraction of the remaining extract was used for determination of mutagenic activity.

In addition to collection of samples by concentration on polyurethane foams, 2 gallons of unconcentrated water were also collected from each sampling point for determination of mutagenic activity. Collapsable polyethylene bottles of one gallon capacity were rinsed three times with the water to be collected prior to filling the bottles with water. A small air space was left in each bottle for expansion of water during cooling. The bottles were capped with plastic screw caps, cooled in ice, and transported to the laboratory via air freight.

Plastic sampling bottles were chosen over glass bottles primarily for their ease in handling and shipping; however, consideration was given to the effect of these bottles on the sample composition. It is known that both glass and plastic bottles have been demonstrated to absorb some organic compounds present in water. It is reasonable to assume that the mutagenicity of the nonpolar compounds in our systems was evaluated by Ames assay on the concentrated samples from the foam plugs (foam plugs will concentrate nonpolar compounds). The Ames assay on the unconcentrated samples was performed primarily to assess the mutagenicity of the polar compounds. Since the degree of adsorption of polar compounds on glass surfaces may be more than on polyethylene surfaces, the selection of polyethylene

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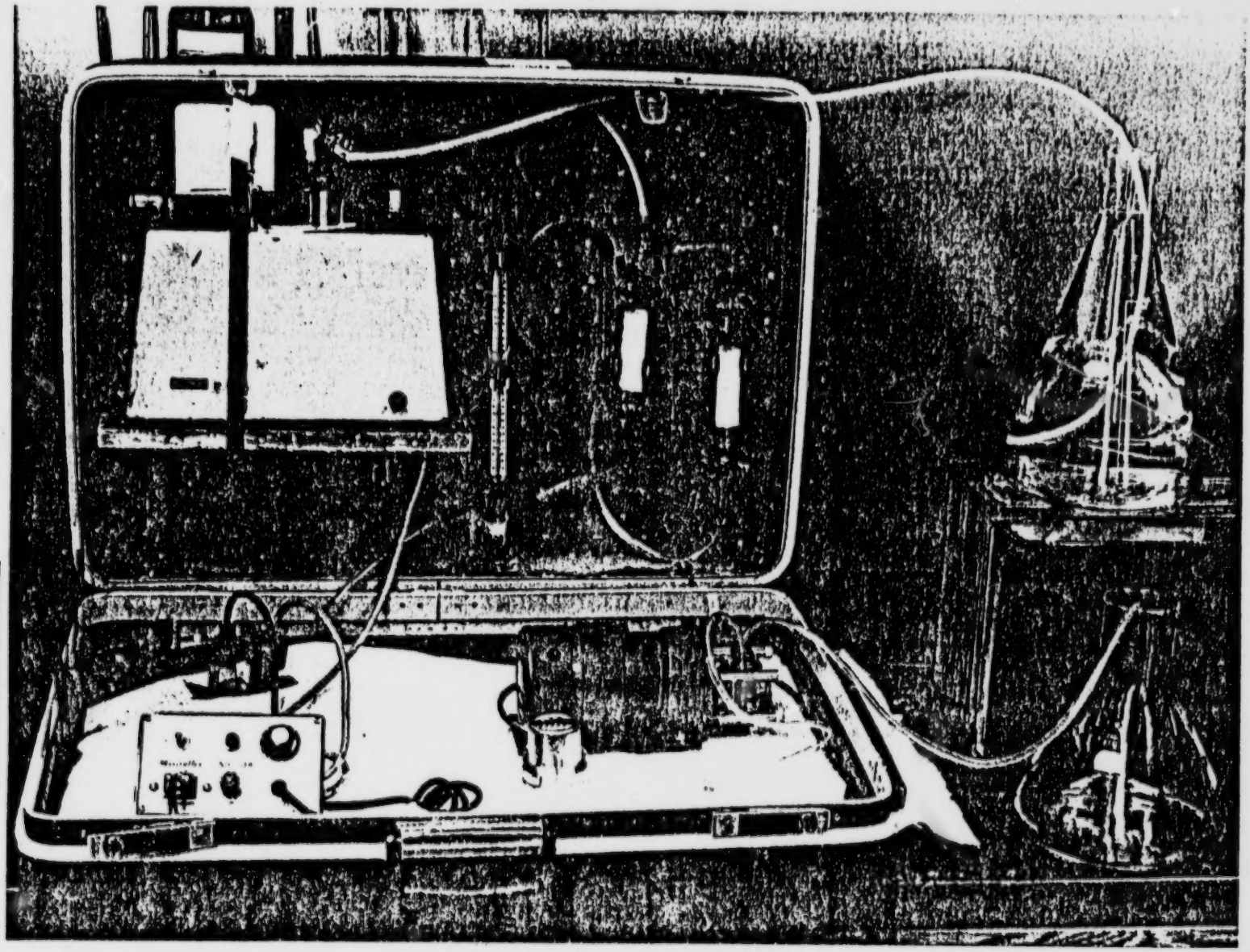

Figure 1. Portable sampling suitcase used to collect organic contaminants from drinking water.

bottles for collection of samples may be preferable to glass containers. As a control experiment, distilled water was stored in a plastic bottle in a manner similar to that used in sample storage. Subsequent mutagenicity tests on the water indicated that no detectable leaching of active componds occurred from these bottles.

Sample Collection Points at Each Water Supply--

At each of the sampling locations, samples were collected at four different points. These were raw water and finished water, both usually at the water treatment plant, and two samples of finished water. The finished water was sampled after passage through different lengths of distribution pipes. Where possible the two sampling points were chosen at the furthest distance from the treatment plant which would be consistent with obtaining water which had passed through two different kinds of distribution pipes. These samples represented the maximum exposure of the finished water to the two different pipes. In locations where the distribution system consisted of only one kind of pipe, one sample was taken at the most distant practical point from the treatment plant and represented maximum exposure to the distribution pipe, while the other sample was obtained from an intermediate point in the system. The sampling points are diagrammatically shown in Figure 2.

The following procedure was used for selecting the two sampling points in each water distribution system. The contact person at the Water Treatment Plant was notified through a letter about the intended date and purpose of our visit, approximately two weeks before the actual sampling date. This provided adequate time for the personnel of the Treatment Plant to review their records and maps and select a few sections of the distribution lines that would serve as suitable sampling points for the study. At the time of acutal sampling, SRC staff, after consultation with appropriate Plant personnel about the characteristics of the pipes in the distribution system, selected the two sampling points for collection of distribution waters. In the majority of cases, the information provided by the personnel at the utilities regarding the age, condition and even the nature of the pipes lacked the desired reliability. It is recommended, for two reasons, that in future investigations of this nature, the majority of sampling points in the distribution lines be selected from sections that had recently installed pipes. Since the records for recently installed pipes are more easily accessible, this will assure that the data regarding the pipe characteristics are more reliable. Also, the possibility of leaching from freshly installed pipes can be expected to be greater than from older pipes.

The two finished water samples representing exposure to the distribution lines were usually collected from water taps inside motels, private or public buildings at approximately the desired distances from the treatment plant. To avoid the collection of contaminants which resulted from leaching plumbing lines in these buildings (as opposed to contaminants leaching from the distribution line), running water from lines flushed for 5 to 10 minutes was used to obtain samples.

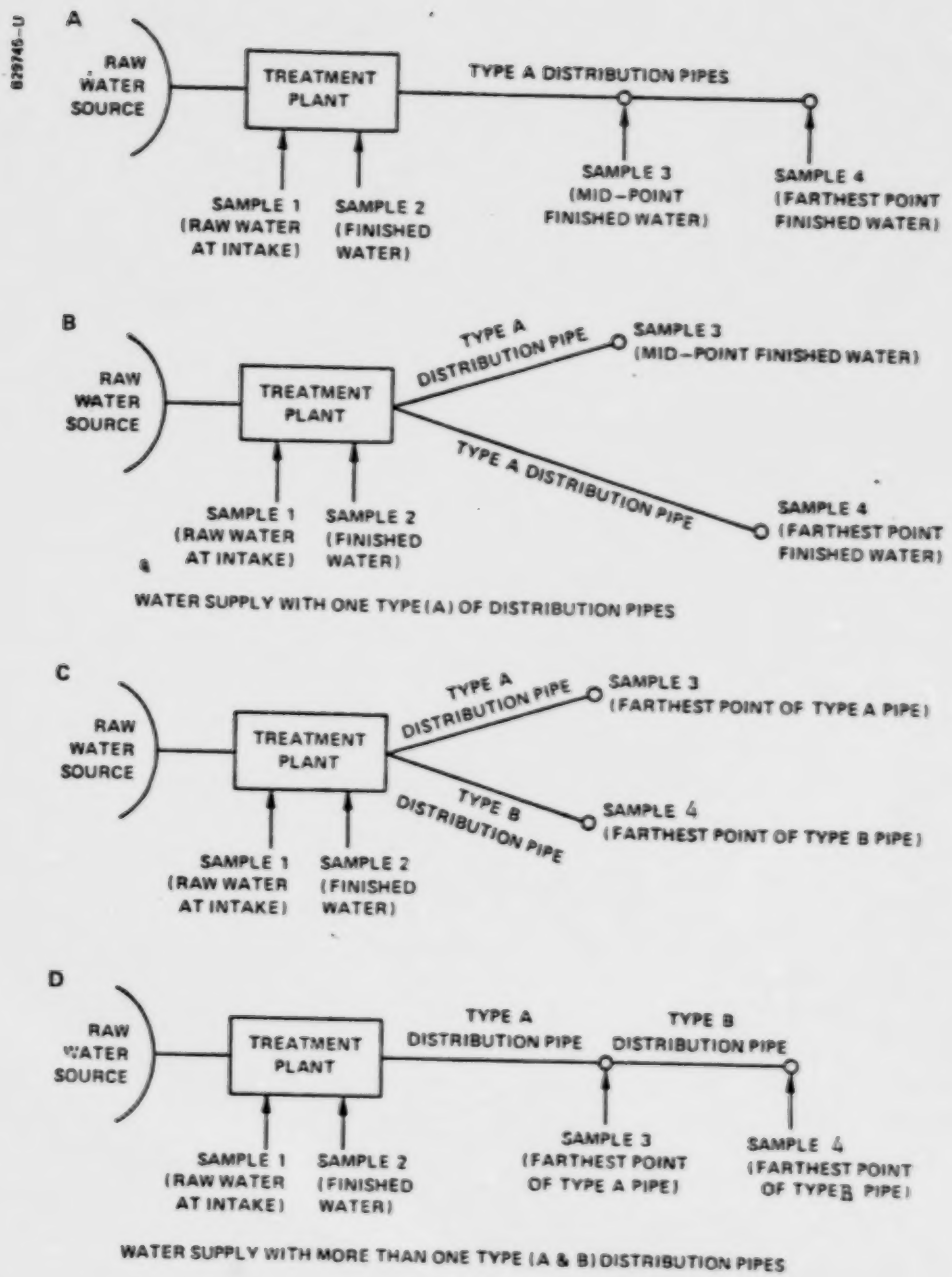

Figure 2. Locations and configurations of sampling points points after the passage of potable waters through distribution pipes

Table 3 describes the type of pipes the finished water passed through before reaching the sampling points (sample 3 and sample 4 in Figure 2), the distance the finished waters travelled through these pipes and the configuration of the distribution system with respect to the treatment plant. It should be pointed out that the distances given in Table 3 refer to the approximate distances travelled by the waters through the pipes (the distribution lines were not always straight and could be circuitous) and not the actual distance of the sampling point from the treatment plant.

Elution of PAH from Foam Plugs

The PAH were eluted from the foam columns by washing each column with 30 ml acetone and 125 ml cyclohexane. The details of the elution procedure are given elsewhere (Saxena et al., 1977a). Several impurities belonging to foam plugs were also collected during the elution process. With the exception of trace amounts of fluoranthene and benzo(ghi)perylene, other interfering impurities originating from the foam plugs could be eliminated by precleaning plugs with benzene or cyclohexane as detailed by Saxena et al. (1977a).

PAH Separation and Analysis

PAH Separation--

During the concentration of PAH from water, several other water contaminants were also concentrated on the foam plugs and some of them coeluted with PAH during the elution step. These impurities interfered with the analysis of PAH and a cleanup procedure was found necessary. The first cleanup step consisted of the solvent partitioning procedure of Hoffman and Wynder (1960) as modified by Acheson et al. (1976). However, this procedure alone was inadequate, and additional cleanup involving liquid chromatography through a short Florisil-column was found to be necessary to further separate the PAH from impurities. Following cleanup, the extract was concentrated to 0.1 ml by a combination of evaporation in a rotary evaporator and under a stream of nitrogen gas. The details of the cleanup and concentration procedure are described elsewhere (Basu and Saxena, 1978b; Saxena et al., 1977a).

Addition of Internal Standard for the Determination of Recovery Factor--

The loss of PAH during the elution and purification procedure was monitored for each analysis by the addition of an internal standard of ^{14}C-benzo(a)pyrene to the foam plugs prior to initiating sample workup. A known amount of radio labeled compound (quantity usually less than 10 ng) was added to the foam plugs, PAH eluted, purified and concentrated to 0.1 ml as described in the preceding section. A 10 ml aliquot of the concentrate was assayed for radioactivity by liquid scintillation counting. The recovery factor was determined from the amount of radioactivity initially added to the foam plugs.

Table 3. Distance, Type and Configuration of the Distribution Pipes in the Supply Systems Used for Sampling

Location of Supply System	Distance from treatment plant and type of pipes at sampling point 3	Distance from point 3 or treatment plant and type of pipe at sampling point 4[a]	Configuration of distribution pipes
Appleton, Wisconsin	Approx. 3 miles of concrete pipes and 1.6 miles of cement-coated ductile iron pipes.	Approx. 3 miles of concrete (same as Point 3) pipes and 3.5 miles of cast iron and cement-coated ductile iron pipes.	Similar to Fig. 2C.
Augusta, Georgia	Approx. 2.5 miles of cast iron pipes.	Approx. 1 mile cement-coated cast iron and 1 mile asbestos/ cement-coated cast iron pipes.	Similar to Fig. 2D.
Austin, Texas	Approx. 4 miles of cement-lined steel pipes.	Approx. 5.5 miles of cement-lined steel pipes.	Similar to Fig. 2B.
Billings, Montana	Approx. 2 miles of cast iron and ductile iron pipes.	Approx. 1 mile of cast iron pipes.	Similar to Fig. 2A.
Champaign, Illinois	Approx. 2 miles of cast iron pipes.	Approx. 3.5 miles of cast iron pipes.	Similar to Fig. 2B.
Champaign, Illinois second trip	Approx. 1 mile CI pipes (different from previous trip).	Approx. 1 mile of CI/DI pipes (a section of the previous line).	Similar to Fig. 2B.
Eau Clair, Wisconsin	Approx. 2.5 miles of ductile iron pipes.	Approx. 4 miles ductile iron pipes.	Similar to Fig. 2A.
Elkhart, Indiana	Approx. 1.5 miles of CI/DI pipes.	Approx. 1.5 miles cement-coated CI/DI pipes.	Similar to Fig. 2D.
Elkart, Indiana Second trip	Approx. 1 mile of CI/DI pipes (a section of previous line).	Approx. 2 miles of cement-coated CI pipes (different from previous line).	Similar to Fig. 2C.
Fairborn, Ohio	Approx. 4 miles of CI/DI pipes.	Approx. 2.5 miles of cement-coated CI pipes.	Similar to Fig. 2C.

(Continued)

Table 3. (Continued)

Location of Supply System	Distance from treatment plant and type of pipes at sampling point 3	Distance from point 3 or treatment plant and type of pipe at sampling point 4[a]	Configuration of distribution pipes
Fairborn, Ohio second trip	Approx. 3.5 miles of CI/DI pipes (a section of previous line).	Approx. 7.5 miles of CI/DI pipes (different from previous line).	Similar to Fig. 2A.
Fayetteville, North Carolina	Approx. 3 miles of cast iron, ductile iron and a small section of cement-lined ductile iron pipes.	Approx. 3 miles of asbestos/cement pipes.	Similar to Fig. 2D.
Fond Du Lac, Wisconsin	Approx. 1.5 miles of cast iron pipes.	Approx. 3 miles of cast iron pipes.	Similar to Fig. 2B.
Fort Meyers, Florida	Approx. 7 miles of cast iron pipes.	Approx. 8 miles of cast iron and 1 mile of asbestos/cement pipe.	Similar to Fig. 2D.
Fort Meyers, Florida Second trip	Approx. 7 miles of CI/DI pipes (different from previous line).	Approx. 15 miles of CI/DI and other pipes (a section of previous line).	Similar to Fig. 2B
Fort Mitchell, Kentucky	Approx. 5 miles of cast iron and ductile iron pipes.	Approx. 20 miles of cast iron, ductile iron and a small section of transient pipes.	Similar to Fig. 2A
Fremont, Ohio	Approx. 3 miles of cement CI/DI pipes.	Approx. 3 miles of cement-coated CI/DI pipes.	Similar to Fig. 2B
Fremont, Ohio Second trip	Approx. 2 miles of cement-coated CI/DI pipes (a section of previous line).	Approx. 4.5 miles of cement-coated CI/DI pipes (different from previous line).	Similar to Fig. 2A
Hutchinson, Kansas	Approx. 3 miles of cast iron pipes.	Approx. 2 miles of asbestos/cement pipes.	Similar to Fig. 2C.
Iowa City, Iowa	Approx. 1.5 miles of cement-coated cast iron pipe.	Approx. 3 miles of cement-coated cast iron pipes.	Similar to Fig. 2B.

(Continued)

Table 3. (Continued)

Location of Supply System	Distance from treatment plant and type of pipes at sampling point 3	Distance from point 3 or treatment plant and type of pipe at sampling point 4[a]	Configuration of distribution pipes
La Crosse, Wisconsin	Approx. 3 miles of cast iron pipes.	Approx. 4 miles of cast iron pipes.	Similar to Fig. 2A.
Merced, California	Approx. 3 miles of cast iron and ductile iron pipes.	Approx. 3 miles of cast iron and ductile iron pipes.	Similar to Fig. 2A
Nampa, Idaho	Approx. 2 miles of cast iron, ductile iron, a small amount of transient pipes.	Approx. 2.5 miles of cast iron and 1800 ft. plastic pipes.	Similar to Fig. 2C.
Olympia, Washington	Approx. 8 miles of concrete pipes.	Approx. 12 miles of cast iron pipes.	Similar to Fig. 2C.
San Luis Obispo, California	Approx. 4 miles of cast iron and ductile iron pipes.	Approx. 2.5 miles of cast iron and ductile iron pipes.	Similar to Fig. 2A.
Tuscaloosa, Alabama	Approx. 4.5 miles of asphalt-coated CI/DI pipes.	Approx. 4 miles of CI/DI pipes.	Similar to Fig. 2D.
Wheeling, W. Virginia	Approx. 4 miles of mixed pipes consisting of copper, cast iron, cement-coated ductile iron and asbestos/cement pipes.	Approx. 8 miles of mixed pipes consisting of copper, cast iron, cement-coated ductile iron, and asbestos/cement pipes.	Similar to Fig. 2A.
Wichita Falls, Texas	Approx. 1 mile cast iron pipe.	Approx. 2 miles asbestos/cement pipes.	Similar to Fig. 2C.
Yakima, Washington	Approx. 7 miles of cast iron and ductile iron pipes.	Approx. 5 miles of cast iron and ductile iron pipes.	Similar to Fig. 2A.

[a] The distance given are from sampling points 3 for distribution lines with configuration similar to Fig. 2A and Fig. 2D and from the treatment plants for distribution lines with configuration similar to Fig. 2B and Fig. 2C.

PAH Analysis

The PAH quantified in the present study were fluoranthene, benzo(j)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene and benzo(ghi)perylene. The compounds selected can be regarded as representative of the whole polynuclear family, and examination of their presence in drinking waters has been recommended by the World Health Organization (1971). PAH analysis was performed using two techniques: gas chromatography-FID detection and thin-layer chromatography-fluorescence detection.

Our earlier studies (Saxena et al., 1977a) demonstrated that a packed and temperature-programmed Dexsil-300 GC column failed to provide adequate resolution for some of the PAH, resulting in erroneously high values. Therefore, with the exception of the samples from the first six locations, all samples collected after 8-1-80 were analyzed by SE-54 wall-coated glass capillary columns. The details of the operating conditions for this packed column are given elsewhere (Basu and Saxena, 1978b). The conditions used for the capillary GC analaysis are given below:

Injection mode: Splitless
Vent delay: 40 seconds
Septum purge flow rate: 3 ml/min
Split vent flow rate: 60 ml/min
He carrier gas linear velocity: 25 cm/sec

Detector gases:
N_2 make-up gas flow rate: 51 ml/min
N_2 gas flow rate: 39 ml/min
Air flow rate: 300 ml/min

Column Programming:
Initial temp.: 160°C
Program rate : 8°C/min
Final temp. : 270°C
Final hold : 65 mins for 30 m column and 45 mins for the 15 m column

Injection port temp.: 250°C
Detector temp. : 350°C

Nitrogen was used as the detector make-up gas to enhance the sensitivity of the detector. The sample injection technique and the special nature of the injection port septa used have been previously described (Basu and Saxena, 1978b).

Thin-layer chromatography was performed using a slight modification of the plate coatings of Borneff and Kunte (1969). The plates were developed in two dimensions. The details of the preparation of TLC plates and the method for solvent development have been described by Saxena et al. (1977a).

The identification of PAH spots on the TLC plates were made by two methods. The first method, an approximate one, was based on the R_B values of the spots. The R_B values were defined as the ratio of distance travelled by a specific compound to that of benzo(a)pyrene in the two solvent systems. Since R_B values were found to be somewhat variable depending on the thickness of coating material, solvent composition and other undetermined factor(s), the unequivocal identification of a compound was made by the excitation and emission spectra of the individual spot directly on the plate at room temperature with an Aminco thin-film scanner attached to an Aminco-Kiers spectrophotofluorimeter.

For quantification of the spots, the signals of fluorescence emission intensities of the scanned spot produced by the photomultiplier were transferred (as input) to a strip chart recorder (50 mv full scale deflection). The peaks were manually integrated for area determination. The *in situ* scanning eliminated the losses usually encountered during removal of PAH spots for fluorescence measurement in solvents, and the interferences arising due to solvent interactions. The details of the TLC identification and quantification of the spots are reported elsewhere (Basu and Saxena, 1978b; Saxena *et al.*, 1977a).

Assay of Mutagenic Activity

The bioassay employed in the present study utilizes the histidine-requiring strains of the bacteria *Salmonella typhimurium* developed by Ames and coworkers (1975). This *in vitro* bioassay is presently one of the most widely known and frequently used test systems to detect the mutagenic effects of chemical substances. The Ames test has the advantages of speed, ease of testing, low cost, and the generation of relatively precise results. This assay can detect point mutations of both the frameshift and base-pair substitution types. The assay has the capacity to approximate metabolic activation of the test substances by the incorporation of a microsome-containing subcellular preparation obtained from rat liver (S-9 mix). A flow diagram of the bioassay procedures used during the present studies is presented in Figure 3.

The assays were performed in both the presence and absence of a mammalian metabolic activation (S-9) system. The following is a brief description of the tester strains used in the present study:

TA1535 - Strain reverted by mutagens which cause base-pair substitutions

TA1537 - Strain that is reverted by mutagens causing frame shift suppression in G-C rich regions

TA1538 - Strain reverted by mutagens causing frame shift suppression as small deletions in G-C base-pair regions

TA98 - Similar to TA1538 above, but possessing a pKM 101 plasmid containing an ampicillin resistance gene and a "mutator" gene, which increases sensitivity to mutagens

TA100 - Strain derived from TA1535 and like TA98, possesses a pKM 101 plasmid for ampicillin resistance, and a "mutator" gene

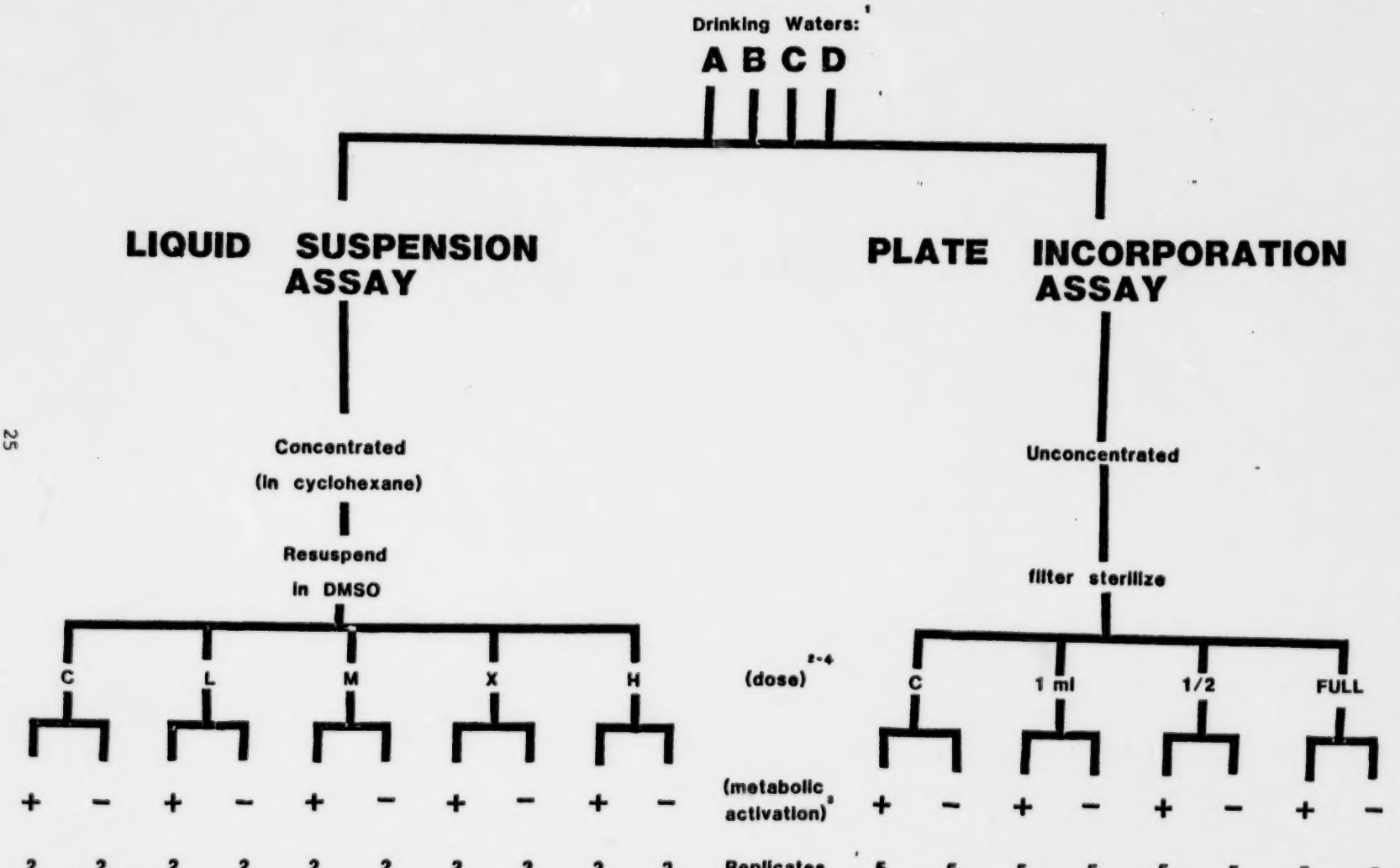

Figure 3. Experimental Design of Bioassays

[1]Drinking waters: A = Raw Water, B = Finished Water, C = Distribution Point I, D = Distribution Point II

[2]Dose: Plate Incorporation Assays: FULL = 25 ml/plate, 1/2 = 12 ml/plate, 1 ml = 1 ml/plate; Liquid Suspension Assays:H = 150 ml/plate raw water, 300 ml/plate others; X = 100 ml/plate raw water, 200 ml/plate others; M = 50 ml/plate raw water, 100 ml/plate others; L = 25 ml/plate raw water, 50 ml/plate others.

[3]Metabolic Activation: + = S-9 mix present, - = S-9 mix absent.

[4]The dose levels of H, X, M, L, and C are described in the section on Preparation of Water Concentrates for Ames testing.

Methods for Routine Bioassays--

Strains of S. typhimurium are routinely cultured in our laboratory, and are stored as frozen bacterial concentrates at -80°C. The following procedures describe the methods employed for the routine handling and storage of the tester strains, the preparation of the metabolic activation system, and the preparation of minimal media/agar plates used in the assay.

Preparation of Cell Suspension--Cell suspensions of the Salmonella tester strains for the present study were prepared using a modification of the Ames procedure. Instead of growing fresh cultures each time an assay was performed, large batches of subcultured bacteria were prepared and stored frozen at -80°C. Aliquots of these frozen cells were used directly in the bioassay after thawing and making the appropriate dilutions. In this manner the cells from a single subculture could be used for a number of bioassays performed on different days. The bacteria were grown, harvested, and stored by the following methods.

A subculture of the tester strain was prepared by innoculating 100 ml sterile nutrient broth (8 gm DIFCO Nutrient Broth, 15 ml 0.2% L-cysteine; in 1000 ml distilled water) with bacteria from a frozen stock culture. The innoculated broth was gently shaken in a water bath at 37°C for 16 to 18 hours, followed by asceptically harvesting the cells by centrifugation at 5500 rpm for 15 minutes. The spent broth was discarded and the remaining bacteria pellet was resuspended in sterile nutrient broth supplemented with 20% sterile glycerine as a cryo-protective agent. The cell density of the suspension was in the range of 5 to 9 x 10^9 cell/ml. The cell suspension was asceptically transferred in 15 ml aliquots into vials and stored at -80<C until used. This technique eliminated the necessity for the growing of bacterial strains for each experiment, and also eliminates problems of sparse "lawns" which may arise with the slower growing Salmonella strains. The efficiency of frozen bacteria in the detection of known mutagens was compared with fresh overnight cultures for all strains, both with and without metabolic activation. The diagnostic mutagens used in this study were 4-nitro-o-phenylenediamine, methyl methansulfonate, 9-aminoacridine. The spontaneous rate varied slightly between the two types of cultures in a random fashion which were within the limits normally observed among assays performed on different days. With the postive mutagens the frozen cultures were slightly less efficient than the fresh culture; however, this only represented an approximate 10% decline in the number of revertants. This technique leads to an improvement in the reproducibility of the Ames' assay, and saves time. This procedure yields reproducible results even when aliquots of cells were used after two months of storage at -80<C.

Preparation of the Mammalian Metabolic Activation System (S-9)--Metabolic activation in the bioassay was achieved by incorporation of the 9000 x g supernatant of a liver homogenate from rats previously injected with a polychlorinated biphenyl (PCB) in order to induce microsomal enzyme activity. The procedure as reported by Ames et al. (1975) for the preparation of the rat liver homogenate, the S-9 fraction, and the S-9 cofactor mix was employed without modification. The agent used for induction of the rat liver enzyme system was a mixture of

polychlorinated biphenyls (PCB) under the trade name Aroclor 1254. Aroclor dissolved in corn oil (100 mg in 0.5 ml cornoil) was administered as a single intraperitoneal injection at a dosage of 500 mg/kg. To minimize potential differences among individual animals, at least three rats were used in the preparation of the S-9 mix. The rats were allowed 5 days for induction of liver microsomal enzymes.

Preparation of Test Plates--The minimal plates were prepared by the procedure of Ames. The following method was used for preparing Media/Water plates in order to enhance the possibility of detecting low levels of mutagens in unconcentrated water samples. In a 600 ml prescription bottle, 30 gm DIFCO Bacto-agar was added to 550 ml distilled water. Simultaneously, 40 ml of 50x minimal salts concentrate was added to a two liter Florence flask. For those flasks for which half-strength media was required, 700 ml distilled water was added to the appropriate flask. Both the agar and the salts or salts/water flasks were autoclaved at 250°C and 15 psi for 15 minutes. After autoclaving, 5 ml of sterile 40% glucose was added to each of the flasks. For those flasks used to prepare plates with the maximum amount of test water, 1400 ml of filter-sterilized test water was added. For the half-strength flasks, 700 ml filter-sterilized test water was added to the appropriate flask. The contents of all flasks were brought to 50°C in a water bath. The molten sterile agar was added and mixed in each flask. Into 15 x 100 mm plastic petri dishes, 25 to 28 ml of the media/water was asceptically poured. The final amount of test water in the full-strength plates was approximately 25 to 28 ml per plate and 12.5 ml per plate in the half-strength plates. These media/water plates were used to assay unconcentrated water samples in the plate incorporation assays.

Preparation of Water Concentrates for Ames Testing--Organic concentrates of water were received from the analytical laboratory for mutagenicity testing in 20 ml of cyclohexane. The water concentrates represented 10 liters of water from the raw-water source or 15 liters of water from the treated and distribution sources. Aliquots of each cyclohexane concentrate were transferred to separate tubes. The cyclohexane was evaported with nitrogen at 40<C until dry. Upon complete drying the residue was resuspended in sterile DMSO to provide a stock solution from which subsequent dilutions were made. The stock solutions provided the "H" (high) dose solution for each sample location. For the raw water samples the "H" dose represented the equivalent of a 150 ml water per 0.1 ml of the final DMSO solution. Subsequent raw water dilutions were: "X" (intermediate) dose, 100 ml water per 0.1 ml DMSO, "M" (medium) dose, 50 ml water per 0.1 ml DMSO, and "L" (low) dose, 25 ml water per 0.1 ml DMSO. For the treated and both of the distribution water samples the "H" dose represented 300 ml per 0.1 ml DMSO solution. Subsequent dilutions for each sample were "X" dose, 200 ml water, "M" dose, 100 ml water, or "L" dose, 50 ml water per 0.1 ml DMSO solution. The amount of water to be tested at the highest dose was chosen as a result of previous studies with drinking water and raw water which indicated that these doses represented the minimum levels which begin to be toxic to the tester strains. Although it was apparent that some water samples could be assayed at higher levels than those employed, many others could not. For each concentration assayed by liquid suspension 0.1 ml of the appropriate DMSO water concentrate solution was used. The sample labeled C was the control.

Quality Controls--The performance of the mutagenicity assays was routinely examined using diagnostic mutagens as positive controls. These controls were performed on each new subculture of the tester strains prior to their being frozen. Previous studies in this laboratory indicated that the characteristics tested for in this quality control procedure were stable in the frozen bacteria. Diagnostic test substances of known mutagenic potential and not requiring prior metabolic activation, included:

TA98	4-nitro-o-phenylenediamine
TA100	methylmethane sulfonate
TA1535	methylmethane sulfonate
TA1537	9-aminoacridine
TA1538	4-nitro-o-phenylenediamine

The performance of the mutagenicity assays involving metabolic activation was verified by the use of 2-aminoanthracene as a diagnostic positive control mutagen for all tester strains in the presence of the S-9 metabolic mix.

Confirming the tester strains' genotypes for the presence of the R-factor conferring ampicillin resistance in strains TA98 and TA100 was routinely performed. Amplicillin-containing filter-paper discs containing 10 ≈g of ampicillin were placed in the center of nutrient agar petri dishes overlaid with each of the desired tester strains. Zones of bacterial growth inhibition after 24 hours incubation at 37<C were observed, as expected, with tester strains TA1535, TA1537, and TA1538, but not with strains TA98 or TA100.

To confirm the presence of the tester strains' deep rough mutation (fra), which permits large molecules to enter the bacteria and inhibit growth, a crystal violet test was carried out in conjunction with the ampicillin resistance test. A sterile filter paper disc containing 10 μg crystal violet (10 ≈l of a 1 mg/ml solution) is placed onto nutrient-agar plates containing bacteria. After 12 to 24 hours incubation at 37<C a clear zone of growth inhibition around the disc indicates the presence of the deep rough mutation. Also, histidene dependence was assessed at the time of each assay.

Experimental Procedures--

Two variations of the standard plate incorporation assay were used to assess the mutagenic potential of drinking waters. One such procedure was designated as the "Media water assay," and employed unconcentrated, filter-sterilized drinking water samples. The second procedure was designated the "liquid suspension assay," and employed organic concentrates of the drinking water samples. Details of the two experimental procedures are provided in the following sections.

Media Water Plate Incorporation Assay--Any single method for collecting and concentrating organic contaminants from water is not 100% effective, and methods that do not concentrate large quantities of inorganic comounds also allow many polar organic compounds to escape collection. Since this was also the case with the use of polyurethane plugs as an adsorbent, it was considered necessary to attempt to determine if mutagens were present in our water samples which evaded concentration. Although it is realized that detecting mutagens in unconcen-

trated water is difficult, because of the low levels of contaminants present and the limitation on the sample size which can be analyzed, attempts were made to determine the mutagenic potential of unconcentrated water by optimizing the amount of water which could be incorporated into the assay. To facilitate the detection of low concentrations of mutagens in unconcentrated drinking water samples, the bioassay procedure was modified by incorporating filter-sterilized test water into the base agar. Two different amounts of test water in the media were obtained by dilution of the test water with an appropriate volume of distilled water prior to the preparation of the media.

For the actual plating procedure sterile 100 x 13 mm glass tissue culture tubes containing 3 ml of the top agar and 0.3 ml of a 0.5 mM histidine/0.5 mM biotin solution were supplemented with 0.1 ml of the appropriate bacterial suspension and 0.5 ml of the S-9 mix (where appropriate). The contents of each tube were overlaid onto the base agar layer. Suspect mutagens would therefore be present in the base layer, and test organisms and the S-9 mix would be present in the top agar. This procedure allowed for incorporation of approximately 25 or 12.5 ml of drinking water per plate (70% of the total volume for the highest concentration).

A third level of exposure was included in the protocol by adding 1.0 ml of filter-sterilized drinking water into the agar-histidine/biotin top agar solution, before supplementation with the appropriate bacterial tester strain and S-9 mix (where required). This "1 ml" exposure was plated onto standard minimal-media plates in a manner similar to a plate incorporation assay. Assays on all the water samples collected from one location were performed at the same time along with distilled water controls for spontaneous reversion rate and positive mutagenesis controls. Therefore, three concentrations of 25, 12.5 and 1 ml of water per assay-plate were used to obtain dose response information and each assay point contained 5 replica plates.

All assays were performed in quintuplicate. Plates were incubated at 37<C in a Sherer Lab incubator for 96 hours before enumerating the colonies on the Biotran II automatic colony counter. The results were recorded as number of revertants counted per plate, and expressed as means ($\pm$ standard deviation) of the quintuplicate determinations. Also, the ratio of experimental ÷control was calculated.

In previous laboratory studies conducted at SRC (Neal et al., 1980) using known mutagens, it was demonstrated that the same mutagens added to the bottom agar were detected with lower efficiency than those added to the top agar. For example, benzo(a)pyrene, an extremely hydrophobic molecule, was detected in the media water assay with 10 times less sensitivity compared to the procedure in which the mutagen was added to the top agar; however, mutagens which were more hydrophilic (e.g., nitrosoguanidine) were detected with high efficiency. Thus, although some sensitivity is lost in detecting very hydrophobic mutagens, the ability to add a larger quanity of sample justifies the use of this procedure.

Liquid Suspension Assay of Drinking Water Concentrates--This assay involved incubation of an organic concentrate of water and bacterial tester strains in liquid suspension prior to plating on minimal-media. Liquid suspension assays are particularly valuable with assays that involve complex uncharacterized mixtures, and where the possibility exists that some of the compounds present, or a metabolically activated form of the compounds present, may be inactivated by the agar. All of the positive features of the plate incorporation assay are retained by the liquid suspension assay, therefore this assay can detect any compound which is positive in the conventional plate incorporation assay. Previous preliminary studies have shown that water concentrates gave poor response in the standard Ames plate incorporation assay. DeSerres and Shelby (1979) have recommended the use of the liquid suspension assay where the results of the standard plate incorporation assay are inconclusive.

The liquid suspension assay was used in assessing the mutagenic potential of drinking water concentrates. The pre-incubation medium for this assay contained 1 ml of minimal media (minus agar) broth, 0.5 ml rat-liver homogenate plus cofactors (S-9 mix) where required for metabolic activation, 0.1 ml of the appropriate bacterial tester strain, 4 µg histidine, 6 µg biotin, and the designated amounts of the test drinking water concentrate. Identical vehicle control tubes were made with 0.1 ml of DMSO added. Following a 60 minute incubation of the mixture at 37°C in a water bath, 3 ml of soft agar containing 24 µg histidine and 36 µg biotin per ml was added to each tube. The contents of each tube were mixed and overlaid onto minimal glucose agar plates. The plates were inverted and incubated at 37°C for 96 hours. The colonies were counted and the results expressed as the ratio of the number of revertants colonies per plates receiving exposure to test waters over the number of spontaneous revertants on control plates.

Intrepretation of the Results--In the plate incorporation assays and the liquid suspension assays with test water concentrates, a ratio of revertant colonies (experimental/spontaneous control) of 1.5 to 2.0 was considered to be a weak mutagenic response, and a ratio of > 2.0 was considered as a positive mutagenic response. Chu et al. (1981) have recently demonstrated that the standard statistical methods, one-way analysis of variance and test for linear trends, used in the assessment of results from the Ames assay are not superior to a modified 2-fold rule, and in fact, the statistical methods often generate more false positives. For this reason the modified 2-fold rule as outlined by Chu et al. (1981) was used. This rule was stated as:

> "A test is considered positive if there are average responses that are greater than twice the concurrent negative/solvent control average response in at least 2 consecutive dose levels or in the last non-toxic dose level. In addition, at least 2 of these consecutive doses must possess a dose-response relationship showing increase number of mutant colonies with increasing doses."

SECTION 6

RESULTS AND DISCUSSION

The leaching of PAH from coal tar-coated potable water storage tanks and water distribution pipes has been demonstrated by a few investigators (Borneff, 1976; McClanahan, 1979; Roebeck, 1979; Alben, 1980a). However, only six percent of the total installed potable water distribution pipes in the U.S. consist of steel pipes that are typically lined with coal tar-based coating materials (Goldfarb, 1979). Instead, the majority (75%) of water distribution pipes are made of cast/ductible iron (Goldfarb, 1979). Unlined and cement mortar-lined cast/ductile iron pipes are typically coated with petroleum asphalt paints, instead of coal tar, for corrosion inhibiton and as a curing aid for the pipe linings (Goldfarb, 1979). That these asphalt-based paints contain PAH can be inferred from the investigation of Radding et al., 1975 (see Section 4). The leachability of PAH into potable waters travelling through distribution pipes coated with asphalt-based paints, however, is not well studied. The primary objective of the present investigation was to examine both the change in PAH concentration and the pattern of mutagenic activity in treated waters as a result of their passage through commonly used distribution/transmission pipes.

The sampling locations selected for the study represent the largest water supplies within 24 selected counties in the U.S. These water supplies serve areas that represent both high and low colon, rectum, bladder, and liver cancer mortality rates for females as established by U.S. EPA epidomiological study (Kopfler, 1977). To avoid bias in the analysis, however, the relative cancer mortality rates among these areas remained unknown to us. As shown in Table 3, the samples collected from these water supplies represent contact with a variety of distribution pipes. The majority of the distribution lines in these locations consist of unlined or cement-lined cast/ductile iron pipes. A small number of samples were collected from concrete, asbestos/cement, cement-lined steel, plastic and copper pipes, or a combination of these. The exact sampling points for each of the water supplies tested are shown in Table 3 and Figure 2. The rationale for selecting the sampling points is given in Section 5.

The presence of a wide variety of PAH, including several animal carcinogens, in environmental samples is not uncommon. For example, in one study (Kunte, 1979), more than 200 different PAH were detected in an ambient air sample. Because it is difficult and generally unnecessary to quantify all PAH in a complex environmental sample, it seems practical to choose a few specific and representative compounds for water monitoring purposes. The six PAH analyzed in this study included fluoranthene (FL); benzo(j)fluoranthene (BjF); benzo(k)-fluoranthene (BkF); benzo(a)pyrene (BaP); indeno(1,2,3-cd)pyrene (IP); and

benzo(ghi)perylene (BghiP). The World Health Organization (WHO) recommends, with the exception of benzo(j)fluoranthene, the analysis of these PAH in drinking water. Benzo(b)fluoranthene, which is recommended for analysis by WHO, was replaced with its isomer benzo(j)fluoranthene in our analysis because benzo(b)-fluoranthene was not available to us as a reference standard. This group of six PAH is regarded by WHO as a reliable indicator of the entire polycyclic family (WHO, 1971). Except for the ease of fluorescence detection and their frequent occurrence in environmental samples, the reason for selecting these six compounds by WHO is not clear (Borneff and Kunte, 1979). In the absence of other guidelines, we decided to analyze the above six PAH for the following additional reasons: the six PAH represent compounds varying from strongly carcinogenic (benzo(a)pyrene) to non-carcinogenic (fluoranthene) (NAS, 1972), and include compounds that are hard-to-separate; i.e., the isomers benzo(j)fluoranthene and benzo(k)fluoranthene. The ability of the analytical method to separate carcinogenic PAH (for example, benzo(a)pyrene) from its nonmutagenic isomer (for example, benzo(e)pyrene) can be tested by including the last two isomers, which are difficult to separate.

PAH represent only one class of biologically active compounds which may be either deposited in raw water or leached from distribution pipes. In order to detect the presence of other biologically active compounds of importance to water quality, an *in vitro* mutageniciity assay was performed on samples from each collection site. This assay was performed on the same organic concentrate used for PAH analyses, and also on the unconcentrated water. The use of unconcentrated water allows for detection of biologically active compounds that are not absorbed by polyurethane foam plugs, as well as compounds which are lost during the extraction and preliminary chemical clean up phases. The experimental bioassay data, expressed as revertants per plate, for each sampling site are tabulated in Appendix A.

The PAH in water samples taken from the different locations were collected by a polyurethane foam retention method. In a previous study (Basu and Saxena, 1978b), the retention efficiency of polyurethane foams for six PAH in finished waters was reported to be nearly 90%. Using the foam concentrative technique described in Section 5, the investigators collected water samples from 24 potable supplies. Water samples from 5 of the 24 supplies were resampled for the following reasons: the water samples collected during the first trip to Fremont, OH; Elkhart, IN; and Fairborn, OH were not analyzed for mutagenic activity, and the original samples collected from Champaign, IL, and Ft. Myers, FL showed elevated levels of mutagenic activity. Therefore, water from these five supplies were resampled primarily for the analysis or confirmation of their mutagenic activity.

RESULTS OF CHEMICAL ANALYSIS FOR PAH

The results of PAH analyses are given in Table 4. The values given for fluoranthene and benzo(ghi)perylene in Table 4 have been corrected for the trace amounts of these PAH contributed by the foam plugs from each lot. The details of these corrections are given elsewhere (Saxena et al., 1977). Benzo(a)pyrene values have been corrected for the amount of radiolabelled compound added as an

Table 4. Results of PAH Analyses of Water Samples

Location & Date of Sampling	Compound	PAH concentration in water, ng/l			
		Raw	Finished	Dist. Pt. 1	Dist. Pt. 2
				C-CI/DI[a]	C-CI/DI
Fremont, OH (First trip) 8-25-77 to 8-28-77	FL	N.D.[c]	N.D.	N.D.	N.D.
	BjF	N.D.	N.D.	N.D.	N.D
	BkF	N.D.	N.D.	N.D.	N.D.
	BaP	N.D.	N.D.	N.D.	N.D.
	IP	N.D.	N.D.	N.D.	N.D.
	BghiP	N.D.	N.D.	N.D.	N.D.
	Totals	N.D.	N.D.	N.D.	N.D.
				C-CI/DI (Same pipe as before)	C-CI/DI (different pipe)
Fremont, OH (Second trip) 4-20-81 to 4-21-81	FL	105.6	N.D.	N.D.	N.D.
	BjK	12.4	N.D.	N.D.	
	BkF	7.7	N.D.	N.D.	53.3[b]
	BaP	2.6	0.2	N.D.	0.2
	IP	10.0	N.D.	N.D.	N.D.
	BghiP	14.6	2.2	N.D.	2.3
	Totals	152.9	2.4	N.D.	55.8
				CI/DI	C-DI/DI
Elkhart, IN (First trip) 9-19-77 to 9-20-77	FL	N.D.	N.D.	N.D.	8.1
	BjF	N.D.	N.D.	N.D.	0.4
	BKF	N.D.	N.D.	N.D.	0.3
	BaP	4.4	N.D.	3.7	0.3
	IP	N.D.	0.3	N.D.	0.6
	BghiP	15.9/15.8[b]	N.D.	N.D.	1.4
	Totals	20.3	0.3	3.7	11.1

(Continued)

Table 4. (Continued)

Location & Date of Sampling	Compound	PAH concentration in water, ng/l			
		Raw	Finished	Dist. Pt. 1	Dist. Pt. 2
				CI/DI (Same pipe as before)	C-CI/DI (different pipe)
Elkhart, IN (Second trip)	FL	N.D.	N.D.	N.D.	N.D.
	BjF	N.D.	N.D.	N.D.	
	BkF	N.D.	N.D.	N.D.	61.0[b]
6-19-81	BaP	1.0	0.4	0.3	0.6
to	IP	N.D.	N.D.	N.D.	N.D.
6-20-81	BghiP	N.D.	N.D.	N.D.	N.D.
	Totals	1.0	0.4	0.3	61.6
				CI/DI	C-CI/DI
Fairborn, OH (First trip)	FL	N.D.	N.D.	N.D.	6.5
	BjF	N.D.	N.D.	N.D.	0.3
	BkF	N.D.	N.D.	N.D.	0.3
10-17-77	BaP	0.3	0.1	N.D.	0.3
to	IP	0.5	0.7	0.4	0.6
10-18-77	BghiP	2.6	2.1	N.D.	0.6
	Totals	3.4	2.9	0.4	8.6
				CI/DI (same pipes as before)	CI/DI (different pipes)
Fairborn, OH (Second trip)	FL	N.D.	N.D.	N.D.	N.D.
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	N.D.	N.D.	N.D.
4-23-81	BaP	N.D.	N.D.	N.D.	N.D.
to	IP	N.D.	N.D.	N.D.	N.D.
4-24-81	BghiP	N.D.	N.D.	N.D.	N.D.
	Totals	N.D.	N.D.	N.D.	N.D.

(Continued)

Table 4. (Continued)

Location & Date of Sampling	Compound	PAH concentration in water, ng/l Raw	Finished	Dist. Pt. 1	Dist. Pt. 2
				CU, CI, C-DI, A/C (Same pipe as before)	CU, CI, C-DI, A/C (different pipe)
Wheeling, WV	FL	756.5/723.0	94.5/111.4	81.7	N.D.
	BjF	180.7	1.4	0.8	1.4
		283.9	24.1	74.4	178.6
	Bkf	115.5	N.D.	N.D.	N.D.
2-2-78	BaP	206.4/432.2	2.1/38.4	0.8/107.6	1.9/259.1
to	IP	180.0/289.0	7.8	3.7	4.9
2-4-78	BghiP	147.0/119.8	32.7	14.1/11.3	21.6/44.5
	Totals	1586.1	138.5	101.1	29.8
				CON, C-DI	CON, CI, C-DI
Appleton, WI	FL	N.D.	N.D.	N.D.	N.D.
	BjF	0.7	0.4	0.4	1.4
	BkF	0.5	0.2	0.3	0.9
3-13-78	BaP	0.6	0.4	0.3	1.2
to	IP	0.9	1.4	1.4	3.3
3-14-78	BghiP	4.4	3.7	5.4	11.2
	Totals	7.1	6.1	7.8	18.0
					CI [d]
Champaign, IL	FL	N.D.	N.D.		N.D.
(First trip)	BjF	0.6	0.3		0.6
	BkF	0.7	0.3		0.5
3-16-78	BaP	N.D.	N.D.		0.5/15.5
to	IP	1.9	0.9		1.1
3-18-78	BghiP	3.7	1.3		3.5
	Totals	6.9	2.8		6.2

(Continued)

Table 4. (Continued)

Location & Date of Sampling	Compound	PAH concentration in water, ng/l Raw	Finished	Dist. Pt. 1	Dist. Pt. 2
				CI (different pipes)	CI/DI (partly same pipes as before)
Champaign, IL (Second trip)	FL	N.D.	N.D.	64.3	N.D.
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	N.D.	N.D.	N.D.
6-22-81	BaP	N.D.	0.1	0.4	0.2
to	IP	N.D.	N.D.	N.D.	N.D.
6-23-81	BghiP	N.D.	N.D.	N.D.	N.D.
	Totals	N.D.	0.1	64.7	0.2
				CI	C-CI, A/C
Augusta, GA	FL	N.D.	N.D.	N.D.	N.D.
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	0.4	N.D.	N.D.
5-7-79	BaP	0.1	trace	trace	N.D.
to	IP	N.D.	N.D.	N.D.	N.D.
5-9-79	BghiP	N.D.	2.8	N.D.	N.D.
	Totals	0.1	3.2	N.D.	N.D.
				CI	CI, A/C
Ft. Myers, FL (First trip)	FL	N.D.	N.D.	N.D.	N.D.
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	0.5	N.D.	0.7
5-14-79	BaP	N.D.	0.3	N.D.	0.2
to	IP	N.D.	N.D.	N.D.	N.D.
5-19-79	BghiP	N.D.	N.D.	N.D.	3.8
	Totals	N.D.	0.8	N.D.	4.7

(Continued)

Table 4. (Continued)

Location & Date Sampling	Compound	PAH concentration in water, ng/l Raw	Finished	Dist. Pt. 1	Dist. Pt. 2
				CI/DI (different pipes)	CI/DI (partly same but shorter pipes)
Ft. Myers, FL	FL	N.D.	N.D.	N.D.	N.D.
(Second trip)	BjF	N.D.	N.D.	0.2	N.D.
	BkF	N.D.	0.5	N.D.	N.D.
8-11-81	BaP	N.D.	0.2	N.D.	N.D.
to	IP	N.D.	N.D.	N.D.	N.D.
8-12-81	BghiP	N.D.	4.5	6.2	2.0
	Totals	N.D.	5.2	6.4	2.0
				CI	CI
LaCrosse, WI	FL	N.D.	N.D.	N.D.	N.D.
	BjF	0.2	0.1	0.3	0.1
	BkF	N.D.	N.D.	N.D.	N.D.
7-12-79	BaP	N.D.	N.D.	0.6	N.D.
to	IP	0.5	0.6	0.9	0.3
7-14-79	BghiP	4.9	3.3	3.6	1.7
	Totals	5.6	4.0	5.4	2.1
				DI	DI
Eau Claire, WI	FL	N.D.	N.D.	N.D.	N.D.
	BjF	N.D.	0.2	0.3	0.7
	BkF	N.D.	N.D.	N.D.	0.3
7-16-79	BaP	N.D.	0.2	0.2	0.2
to	IP	N.D.	0.6	0.7	1.4
7-18-79	BghiP	N.D.	2.7	3.3	4.3
	Totals	N.D.	3.7	4.5	6.9

(Continued)

Table 4. (Continued)

Location & Date of Sampling	Compound	PAH concentration in water, ng/l Raw	Finished	Dist. Pt. 1	Dist. Pt. 2
				CI	CI
Fond Du Lac, WI	FL	N.D.	9.1	N.D.	N.D.
	BjF	N.D.	0.7	N.D.	N.D.
	BkF	N.D.	0.4	N.D.	N.D.
9-26-79	BaP	N.D.	0.1	0.3	0.3
to	IP	N.D.	0.6	N.D.	N.D.
9-28-79	BghiP	0.7	2.5	N.D.	2.8
	Totals	0.7	13.4	0.3	3.1
				C -CI	C-CI
Iowa City, IA	Fl	N.D.	N.D.	N.D.	N.D.
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	N.D.	N.D.	N.D.
10-1-79	BaP	0.4	N.D.	0.3	0.3
to	IP	N.D.	N.D.	N.D.	N.D.
10-2-79	BghiP	7.9	N.D.	0.7	1.7
	Totals	8.3	N.D.	1.0	2.0
				CI	A/C
Wichita Falls, TX	FL	N.D.	N.D.	N.D.	N.D.
	BjF	2.4	N.D.	N.D.	N.D.
	BkF	N.D.	N.D.	N.D.	N.D.
11-17-79	BaP	1.8	N.D.	0.1	N.D.
to	IP	6.9	N.D.	1.3	N.D.
11-19-79	BghiP	30.2	0.2	1.8	2.1
	Totals	41.3	0.2	3.2	2.1

(Continued)

Table 4. (Continued)

Location & Date of Sampling	Compound	PAH concentration in water, ng/l Raw	Finished	Dist. Pt. 1	Dist. Pt. 2
				C-S	C-S
Austin, TX	FL	N.D.	N.D.	N.D.	N.D.
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	N.D.	N.D.	N.D.
11-12-79	BaP	N.D.	1.4	0.5	0.3
to	IP	N.D.	N.D.	N.D.	N.D.
11-14-79	BghiP	18.3	6.9	N.D.	1.8
	Totals	18.3	8.3	0.5	2.1
				AS -CI/DI	CI /DI
Tuscaloosa, AL	FL	N.D.	N.D.	41.0	21.7
	BjK	N.D.	N.D.	1.6	1.7
	BkF	N.D.	N.D.	1.2	1.1
5-5-80	BaP	0.2	0.1	0.5	N.D.
to	IP	1.4	0.5	N.D.	N.D.
5-7-80	BghiP	2.4	1.5	N.D.	3.2
	Totals	4.0	2.1	44.3	27.2
				CI	A/C
Hutchinson, KS	FL	N.D.	N.D.	N.D.	N.D.
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	N.D.	N.D.	N.D.
5-9-80	BaP	N.D.	0.3	N.D.	0.2
to	IP	N.D.	0.6	0.4	0.6
5-11-80	BghiP	N.D.	2.4	1.4	1.1
	Totals	N.D.	3.3	1.8	1.9

(Continued)

Table 4. (Continued)

Location & Date of Sampling	Compound	PAH concentration in water, ng/l Raw	Finished	Dist. Pt. 1	Dist. Pt. 2
				CI /DI	CI
Billings, MT	FL	N.D.	N.D.	N.D.	N.D.
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	N.D.	N.D.	N.D.
6-24-80	BaP	0.1	N.D.	N.D.	N.D
to	IP	N.D.	N.D.	N.D.	N.D.
6-25-80	BghiP	N.D.	N.D.	N.D.	N.D.
	Totals	0.1	N.D.	N.D.	N.D.
				CI /DI, TR	CI, P
Nampa, ID	FL	N.D.	N.D.	6.5	6.7
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	N.D.	N.D.	N.D.
6-27-80	BaP	N.D.	N.D.	N.D.	N.D.
to	IP	N.D.	N.D.	N.D.	N.D.
6-29-80	BghiP	N.D.	N.D.	N.D.	0.9
	Totals	N.D.	N.D.	6.5	7.6
				CI/DI	CI/DI
Yakima, WA	FL	N.D.	N.D.	N.D.	3.4
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	N.D.	N.D.	N.D.
8-19-80	BaP	N.D.	N.D.	N.D.	N.D.
to	IP	N.D.	N.D.	N.D.	N.D.
8-20-80	BghiP	0.6	N.D.	0.5	N.D.
	Totals	0.6	N.D.	0.5	3.4

(Continued)

Table 4. (Continued)

Location & Date of Sampling	Compound	PAH concentration in water, ng/l			
		Raw	Finished	Dist. Pt. 1	Dist. Pt. 2
				CON	CI
Olympia, WA	FL	N.D.	N.D.	N.D.	N.D.
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	N.D.	N.D.	N.D.
8-22-80	BaP	N.D.	N.D.	N.D.	N.D.
to	IP	N.D.	N.D.	N.D.	N.D.
8-23-80	BghiP	0.2	0.6	0.4	N.D.
	Totals	0.2	0.6	0.4	N.D.
				CI/DI	CI/DI
Merced, CA	FL	N.D.	N.D.	N.D.	N.D.
	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	0.2	0.2	0.5
10-14-80	BaP	N.D.	N.D.	N.D.	0.4
to	IP	N.D.	N.D.	N.D.	N.D.
10-15-80	BghiP	1.3	0.7	1.1	1.9
	Totals	1.3	0.9	1.3	2.8
San Luis,	FL	N.D.	N.D.	N.D.	N.D.
Obispo, CA	BjF	N.D.	N.D.	N.D.	N.D.
	BkF	N.D.	0.4	0.4	0.3
10-17-80	BaP	N.D.	N.D.	N.D.	N.D.
10	IP	N.D.	N.D.	N.D.	N.D.
10-18-80	BghiP	0.4	2.7	1.1	0.9
	Totals	0.4	3.1	1.5	1.2

(Continued)

Table 4. (Continued)

Location & Date of Sampling	Compound	PAH concentration in water, ng/l Raw	Finished	Dist. Pt. 1	Dist. Pt. 2
				CI/DI	CI/DI, TR
Ft. Mitchell, KY	FL	3.1	N.D.	N.D.	N.D.
	BjF	1.6	N.D.	N.D.	N.D.
	BkF	1.1	N.D.	N.D.	N.D.
12-16-80	BaP	0.2	N.D.	0.2	0.2
to	IP	N.D.	N.D.	N.D.	N.D.
12-17-80	BghiP	4.8	1.1	4.3	3.7
	Totals	10.8	1.1	4.5	3.9
				CI/DI, C-DI	A/C
Fayetteville, NC	FL	N.D.	N.D.	N.D.	N.D.
	BjF	0.7	N.D.	0.2	0.2
	BkF	0.6	N.D.	0.2	0.2
12-16-80	BaP	N.D.	0.2	0.1	0.1
to	IP	N.D.	N.D.	N.D.	N.D.
12-20-80	BghiP	1.8	N.D.	1.1	1.6
	Totals	3.1	0.2	1.6	2.1

[a]The following abbreviations are used for the pipe materials at distribution point 1 and Distribution Point2:

CU = copper; CI = cast iron; DI = ductile iron; CON = concrete; S = steel; P = plastic; TR = transient lines; C-CI = cement-coated CI; C-DI = cement coated DI; A/C = asbestos-cement; AS = asphalt-based coatings.

[b]These values are derived from GC-FID method. Note that BjF was not separated from BkF by this method.

[c]N.D. = not detected.

[d]The sample concentrates from the two distribution points accidentally got mixed. The results given reflect the pooled concentrations.

internal standard. Correction has not been made for the PAH retention efficiency of the foams, which was assumed to be quantitative. Because the retention efficiency of PAH from foam plugs will always be lower than 100%, the actual amount of PAH in waters should be slightly higher than the values shown in the table. The loss of PAH during solvent extraction of the foams and the subsequent chemical clean up was determined by the addition of radiolabelled benzo(a)pyrene as an internal standard. The amount of radiolabelled benzo(a)pyrene added to each of the samples was such that it provided statistically significant counts over the background and yet did not interfere with the analysis of low level benzo(a)pyrene.

The values of the six PAH determined were corrected using the recovery factor from radiolabelled benzo(a)pyrene. It was assumed that the recovery of all six PAH was the same as the recovery of the benzo(a)pyrene.

The final concentrations of the six PAH presented in Table 4 are based primarily on TLC-spectrofluorometric values. The GC-FID method in the vast majority of cases failed to detect PAH because less than 5 µl of the final concentrate (less than 5% of the total) could be used for quantification, and because the method has a lower sensitivity than the fluorometric method. In cases where both values could be obtained, the GC results served as a crosscheck for the TLC values. In a limited number of cases, the TLC method did not provide concentration values for one or two PAH compounds in the samples because of incomplete separation from impurity spot(s). Some of these compounds were separated and quantified by the capillary GC-FID method. The separability and sensitivity of the capillary GC-FID method was superior for the early eluting peaks, such as fluoranthene, benzo(j)fluoranthene and benzo(k)fluoranthene. As found by other authors (Bjørseth, 1979), benzo(j)fluoranthene and benzo(k)fluoranthene were separated by an SE-54 capillary column.

The detection limit for the six PAH by both TLC-fluorometric detection (Saxena et al., 1977) and capillary GC-FID detection is given in Table 5. The capillary GC-FID detection limit is based on a minimum output response of four times the background values obtained at an output attenuation of 1 x 64 and a maximum sample loading volume of 2 µl from a total of 100 µl concentrate. The detection limits for indeno(1,2,3-cd)pyrene and benzo(ghi)perylene by the GC-method are not shown in Table 5 because neither of these compounds were detected by the capillary GC-FID method in any of the samples. Nevertheless the detection limits for these two compounds by the capillary GC method were higher than those determined by the packed column method. With the slower eluting peaks, similar results were obtained with other capillary columns by Lao et al. (1973).

If PAH contaminants are leached from the pipes or their linings, one would expect enhancement of PAH levels as the treated waters travel through these pipes. Also, in a distribution system served by one kind of pipe, an enhancement of PAH level in waters at an intermediate point of the distribution system should signal a further enhancement of PAH concentration in water at the most distant point of the distribution system. In general, an increase in PAH level was observed in waters after their passage through cast/ductile iron and cement-coated cast/ductile iron pipes. Of the 24 sites monitored for the possibility of

Table 5. Detection Limit for Six PAH by Thin Layer and Capillary Gas Chromatographic Methods

PAH	TLC-fluorometric		Capillary GC-FID	
	Absolute limit, ng	Limit in 60 l water (ppt)	Absolute limit, ng	Limit in 60 l water (ppt)
FL	14.0	2.3	6.2	3.5
BjF	7.5	0.1		
BkF	5.0	0.2	8.3[a]	6.9[a]
BaP	10.0	0.2	10.3	8.6
IP	10.0	0.2	---	---
BghiP	20.0	0.3	---	---

[a] compound not separated by GC

enhancement of PAH concentation by the distribution system, a few showed significant increases in PAH concentrations in waters travelling through at least one sample collection point in the distribution lines. The remainder of the water supplies showed reductions in PAH concentrations.

A correlation between the PAH level in water and the distances these waters passed through the distribution lines was also found. It is evident from Table 4 and Figure 2 that an increase in the distance usually enhanced the PAH levels in water. Because petroleum asphalt-based paints and sealants are employed with cement-coated and uncoated cast/ductile iron pipes, this enhancement of PAH levels may be attributable to the increased leaching of the pipe linings associated with increased contact time inside the pipes. The amount of PAH leached into water, however, was small and found to produce incremental increases in the part per trillion range.

The amount of PAH leached was probably related to the age of the installed pipes. The maximum incremental difference in PAH concentrations of 53.4 ppt, 61.2 ppt, and 42.2 ppt were detected in waters from Fremont, OH; Elkhart, IN; and Tascaloosa, AL respectively. The Fremont, OH water was collected from a recently installed cement-coated cast/ductile iron section of the distribution system. The cast/ductile iron pipes in Tascaloosa, AL were coated with asphalt-based paints and probably were installed recently. Although the age of the pipes in Elkhart, IN was not known, the substantive increase in PAH concentration in water may indicate that a major new section of pipe in the distribution system had been recently installed. It is interesting to note that in all three locations, the increase in the concentration of the more water soluble PAH (Santodonato et al., 1979) accounted exclusively for the substantial increase in the total PAH concentration in the water. Distribution pipes coated with PAH-containing materials tend to leach out the more water soluble PAH, such as flouranthene, at the earlier stages of their use. As the pipes become older, their surfaces become depleted of the more water soluble PAH and the concentration ratio between the less soluble to more soluble PAHs in the leached water increases. This age dependence of PAH leaching was also observed by Alben (1980a) in studies on a coal tar-coated storage tank. Therefore, an increase in the concentrations of the more water soluble PAH in waters from distribution lines provided a further indication that they were recently installed.

The above results indicate that no dramatic leaching of PAH could be demonstrated from petroleum asphalt-based paints and sealants used in the distribution pipes, although leaching was more pronounced for recently installed pipes than from older pipes.

The small amount of PAH detected in the water after passage through cast/ductile iron pipes is not surprising. In a recent investigation, Miller et al. (1981) measured the concentration of the six PAH in water by circulating PAH-free water up to 232 hours through 34' x 6" petroleum asphalt-coated ductile iron pipes. The total PAH concentration in the water after passage through the pipes did not exceed 10 ppt. The concentrations of the six PAH measured in the leached waters from the present investigation were of the same order of magnitude as those determined by Miller et al. (1981).

In certain instances, particularly in waters from Fond Du Lac, WI; Austin, TX; and Wheeling, WV, marked reductions of as much as 98% were observed in PAH concentrations in the waters after distribution. This reduction in PAH concentration cannot be correlated with any specific kind of distribution pipe. While the distribution pipes in Wheeling, WV consisted of a combination of copper, cast iron, cement-coated ductile iron and asbestos/cement, the distribution pipes in Fond Du Lac, WI and Austin, TX consisted of cast iron and cement mortar lined steel pipes, respectively. A possible explanation for the reduction in PAH concentration lies in the age of the distribution pipes. Cast iron and cement-coated cast/ductile iron and steel pipes may be coated with asphalt-based paints and sealants. Up to a certain age, the asphalt coating might continuously leach slowly decreasing amounts of PAH in the travelling waters. When the surface of the pipes becomes depleted of PAH leachables, these surfaces may act, at least temporarily, as a sorbent of PAH as water containing PAH travels through them. The observed decrease in PAH concentration could also be due to interaction of PAH with chlorine present in the waters.

The quality of water as a result of its passage through two other non-metallic pipes, for example, asbestos/cement (Wichita Falls, TX; Hutchinson, KS; and Fayetteville, NC) and reinforced concrete (Olympia, WA), was also examined during this investigation. As expected, with pipes not coated with PAH leachable materials the water passing through these distribution lines showed no change in PAH concentrations other than fluctuation in the concentration of benzo(ghi)-perylene.

Water quality parameters, such as the pH, hardness, and alkalinity of the water may also affect the leachability of PAH from the pipe surfaces. It was shown by McFarren et al. (1977) that the aggressive index of travelling water is important in determining the leachability of asbestos fibers from the asbestos/cement pipes. The laboratory studies of a few investigators (Alben, 1980b; Oyler et al., 1978) suggest the possibility of interaction of residual chlorine in potable waters with the compounds leached from the pipe surfaces. Chlorinated and other oxidized products were identified as evidence of these interactions. Because no dramatic leachings of PAH were observed from the distribution pipes in the present investigation, no attempt was made to study the effect of water quality parameters on the leachability of PAH from the distribution pipes.

No data regarding the precision and accuracy of the results can be given because a single analysis for each sample was performed. The data presented in Table 4, however, were obtained under the following quality assurance conditions.

(1) The retention efficiencies of the 6 PAH by polyurethane foams were determined with PAH-spiked water every time a new batch of foams was purchased. The retention efficiencies were found to exceed 80%.

(2) The recovery of PAH in each sample resulting from foam desorption and chemical cleanup was determined from the recovery of radiolabelled benzo(a)-pyrene that was added as an internal standard.

(3) We analyzed external quality control samples received from U.S. EPA, and the results of these analyses indicated that, at least, our identification methods were accurate. Due to lack of knowledge about the actual concentrations in the control samples (non-certified), the accuracy of quantification methods could not be verified.

(4) Whenever there was more than a 10% variation in the sensitivity of fluorometric detection (due to change in lamp intensity or photocell response) as determined by a standard quinine sulfate spot, fresh fluorometric standard curves were made and used for the determination of unknown sample concentrations.

(5) For samples quantified by the GC-FID method, at least one standard mixture was injected into the GC following sample injection to ascertain any changes in relative retention times and sensitivity of detection.

(6) A fresh solvent and reagent blank was run with the samples whenever a new lot of solvent and/or chemicals was used.

It is evident from Table 4 that with the exception of treated water from Austin, TX, more than 90% removal of PAH was accomplished by the treatment processes in the water supplies when the concentration of total PAH in raw water exceeded 10 ppt. The efficiency of PAH removal by the treatment processes was less significant when the level of total PAH in raw water was less than 10 ppt. In fact, in certain cases as in treated water from Augusta; GA, Ft. Myers, FL; Eau Claire, WI; Fond Du Lac, WI; Hutchinson, KS; Olympia, WA; and San Luis Obispo; CA, the PAH level might have marginally increased as a result of treatment. The increase may be due to the presence of PAH impurities in treatment chemicals or due to leaching of the pipes employed to transport the treated water to the tap (where they were sampled), or both. On the other hand, the reported marginal increase in PAH concentrations may be simply attributed to variations in analytical results.

We studied the possibility of variations in PAH concentration of surface waters in samples collected from Fremont, OH and Ft. Myers, FL at two different times. The raw surface water collected from Fremont, OH during the spring of 1981 showed a large increase of PAH concentration compared to the sample collected from the same location in the summer of 1977. The raw surface water collected from Ft. Myers, FL, however, showed no change in PAH concentration. The observed concentration variation in the Fremont, OH raw water sample might have been due to seasonal variation of PAH concentration, but this possibility was not further explored. In the absence of home heating during the winter months, which represents the largest source of PAH contamination in the environment (NAS, 1972), the surface water from Ft. Myers would not be expected to show any seasonal variation in PAH concentration.

In addition to the six PAH identified and quantified by the TLC-fluorometric and GC-FID methods, a number of unidentified compounds were detected by both methods. For example, in Wheeling, WV raw water samples, as many as 13 luminescent spots remained unidentified on the TLC plate. Some of the unidentified spots on the TLC plates showed characteristic absorption and emission

spectra. One such compound with a characteristic emission spectra that recurred in many water samples is shown in Figure 4. Similarly, the capillary GC-FID method showed the presence of several unidentified compounds in the chromatograms of many of the water samples. The capillary GC-FID chromatogram obtained from Elkhark, IN water samples collected from the four sampling points illustrate the complexity of these chromatograms (Figure 5). These chromatograms also qualitatively demonstrate the changes in the water quality as the raw water is treated to finished water and is finally passed through the distribution pipes. No attempt was made, however, to identify the unidentified compounds.

RESULTS OF MUTAGENICITY ASSAYS

In most cases, the raw water and finished water (before and after distribution) tested in this investigation demonstrated no significant or consistent mutagenic activity in the Ames test system. Thus it is not clear whether the leachate from certain distribution pipes actually contributes to the presence of mutagens or, on the other hand, whether some pipes adsorb mutagens which had not previously been removed during treatment. Of the 24 water supplies tested, two showed no detectable mutagenic activity in either the raw water or water taken from any of the collection points (Table 6). Five other water supplies had a number of sampling sites in which an individual assay point demonstrated a mutation ratio (number of revertants in experimental plate divided by number of revertants in control plates) of between 1.5 and 2.0. The random appearance of these weak mutagenic responses and the concomitant lack of a dose-related increase in mutation rate indicates that these values fall within the normal variation of the Ames assay. This interpretation is more difficult, however, in the cases of Fayetteville, NC and Tuscaloosa, AL a ratio of greater than 1.5 was observed at the highest concentration tested, since this could indicate that a higher dose level would produce a clearly positive response.

The lack of observed mutagenic response, in general, probably results from the absence of sufficient quantities of mutagens in the sample. There is also the possibility that some of these samples contain mutagenic compounds and that the biological activity of these compounds was masked by the presence of toxic substances in the sample. The interference by toxic materials with the performance of the Ames assay has been reported by Heartlein et al. (1981) in a study of the mutagenicity of drinking water in agricultural areas. Since toxicity tests were not performed on any of the water samples or their concentrates, the only detectable evidence of severe toxicity in our investigation would be the absence of a bacterial lawn (the limited growth of histidine-dependent bacteria allowed by the trace amount of histidine supplied by the media in the minimal plate). The absence of a bacterial lawn did not result from the testing of any samples in this study, however, slight bacterial toxicity was occasionally encountered as indicated by a dose-dependent decrease in the number of revertants with some samples.

An example of this toxic effect was observed with the raw water sample from Fremont, Ohio where the average number of revertants for strain TA1535 declined from 79.5 for control to 62.0, 50.0, 56.5, and 8.4 as the dose increased. In the study of Hearthein et al. (1981) the addition of S-9 mix decreased the toxicity of the sample to the test bacteria, however, in the present study the presence of

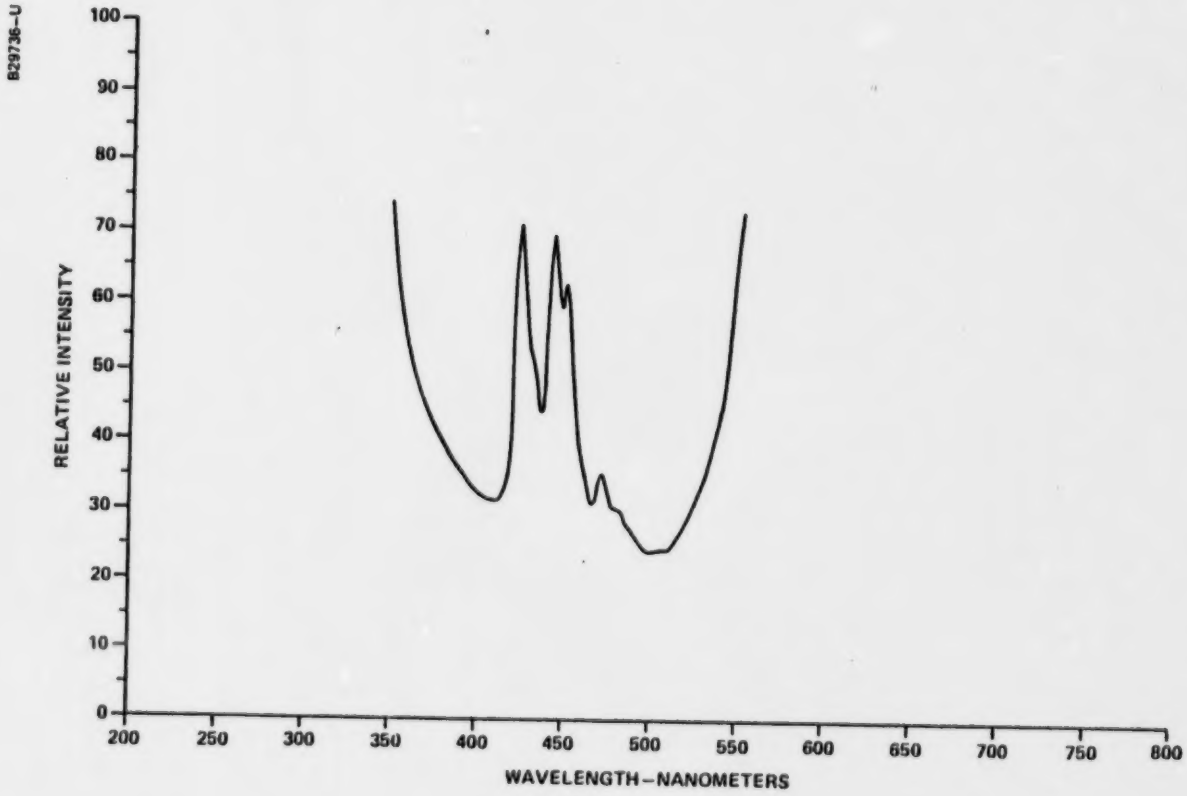

Figure 4. Emission spectra of an unidentified compound that recurred in several samples.

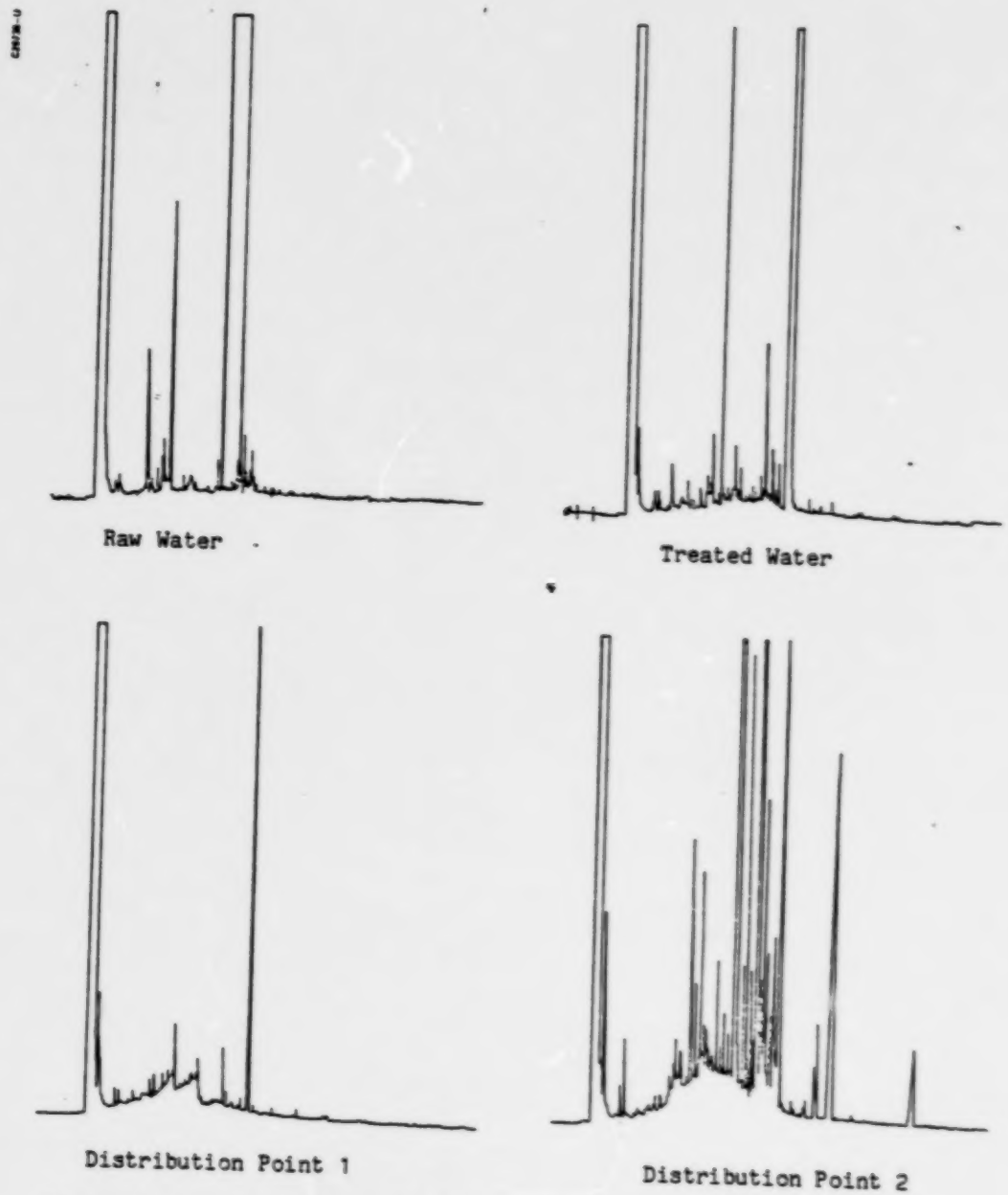

Figure 5. Gas chromatograms of Elkhart, IN samples collected at the four sampling points.

Table 6. Water supplies with no detectable mutagenic activity

Location of Water Supply			
Hutchinson, Kansas	less than 1.5	cast iron	asbestos/cemment
La Cross, Wisconsin	less than 1.5	cast iron	cast iron
Elkhart, Indiana	1.5 to 2.0	cast iron	ductile iron
Tascaloosa, Alabama	1.5 to 2.0	cast iron/ductile iron	cast iron/tar-coated ductile iron
Wheeling, W. Virginia	1.5 to 2.0	mixed pipes	mixed pipes
Fayetteville, N. Carolina	1.5 to 2.0	cast iron/ductile iron	asbestos/cement
Eau Clair, Wisconsin	1.5 to 2.0	iron	iron

S-9 mix decreased toxicity in certain cases while in other cases it increased toxicity. It is apparent from the effect of metabolic activation on bacterial toxicity that the chemical composition and/or amounts of the toxic agents in individual samples varied extensively among the different collection locations. In most samples, the lowest dose tested appeared to be nontoxic to the bacteria.

The types of pipe associated with water samples that demonstrated no mutagenic activity are shown in Table 6. The pipes listed in Table 6 represent all the various types encountered in this study, ranging from the cast iron to asbestos/cement. Although many variables are unknown about the pipes such as age, condition, and the physical properties (pH, types of solutes) of the water, it is apparent that this study shows no consistent relationship between the type of pipe and the absence of observed mutagenic activity in the water which has been transported by these pipes.

Fifteen of the water supplies provided at least one sampling point which either produced a weak mutagenic response or a mutagenic response in at least one of the five strains of bacteria tested. For a response to be considered weakly mutagenic in this study we require that the reversion ratio fall between 1.5 and 2.0 and be accompanied by a positive dose-response trend. A clear mutagenic response in this study was considered to occur when the reversion ratio exceeded 2.0. It should be noted that it is not unexpected to observe mutagenic responses with environmental samples where the high dose point has a lower ratio than the intermediate and low dose point. Such data are generally indicative of the toxicity to the tester strain of bacteria used in the Ames assay. Even in samples demonstrating clear mutagenic potential in this study, the response was not great, with most ratios being only slightly greater than 2.0.

The scoring of samples for positive or negative mutagenic activity was independently conducted by three individuals. Objective evaluation criteria (i.e., doubling of spontaneous reversion rate, and demonstration of dose-related increase in revertants) were employed in the interpretation of all Ames assay results. However, in certain assays where the results were not definitive (e.g., more than a doubling but lack of dose-related increase, or positive dose-response curve, but number of revertants slightly less than twice the spontaneous) a subjective evaluation was also applied to the data. In these cases, a consensus of the three reviewers was obtained before declaring the result to the positive or negative. (These compounds fell into the negative or weekly mutagenic categories). Interpretation of the mutagenicity data is summarized in Table 7; experimental values are presented in Appendix A. The mutagenic activity in Table 7 was expressed as the relative activity as compared to the finished water since this allows easier comparisons of the effect of the distribution system on the quality of the water.

The need for metabolic activation (S-9 mix) was considered when comparing mutagenic response among different points in the sampling scheme; e.g., mutagenicity was considered to be enhanced if distribution point I showed activity in the presence and absence of S-9 mix, while the finished water showed activity only in the absence of S-9 mix. It was necessary to do this in order to account for the appearance of different classes of mutagens in the raw, finished, and distribution system water. In the same manner, the information from the two

Table 7. Variation in Mutagenicity in Raw and Distribution Water as Compared with the Finished Water

Location of Water Supply	Sampling Scheme	Raw Water	Finished Water	Distribution I	Distribution II	Metabolic Activation	Type of Pipe
Billings	A	N	N	N	increased	+/-	cast/ductile iron
Ft. Mitchell	A	increased	N	increased	N	+	cast/ductile iron
Merced	A	N	M	same	same	+	cast/ductile iron
San Luis Obispo	A	N	M	same	same	-	cast/ductile iron
Yakima	A	decreased	M	same	same	+	cast/ductile iron
Austin	B	same	M	same	same	-	cement-lined steel
Champaign (I)	B	N	N	increased	increased	+	
Champaign (II)	B	same	M	same	same	+/-	cast/ductile iron
Fremont	B	increased	N	N	N	+/-	cement-coated cast/ductile iron
Fond du Lac	B	N	M	same	same	+	cast iron
Iowa City	B	N	N	increased	increased	+/-	cement-coated cast iron
Appleton	C	same	M	same	same	-	concrete, cement-coated ductile iron, and cast iron
Fairborn	C	decreased	M	increased	increased	+/-	concrete, and ductile iron
Wichita Falls	C	same	M	same	decreased	-	cast iron, and asbestos/cement
Nampa	C	decreased	M	decreased	decreased	+	cast/ductile iron and plastic
Olympia	C	same	M	decreased	decreased	+/-	concrete and cast iron
Augusta	D	increased	N	N	N	-	cast iron and cement-coated cast iron
Fort Meyers (I)	D	same	M	decreased	N	+/-	cast/ductile iron and asbestos/cement
Fort Meyers (II)	D	same	M	same	same	-	

The designation, same, increased, decreased, refers to the relationships of mutagenic activity at a particular sampling site as compared to the observed activity in the finished water.
N = nonmutagenic; M = mutagenic

types of assays (liquid suspension and plate incorporation) and all bacterial tester strains was used to arrive at a final interpretation with the realization that each tester strain is sensitive to different types of compounds and that each of the two assay systems might actually be evaluating both qualitatively and quantitatively different chemical mixtures from the same sampling point. Thus a sample was considered to be positive if either the liquid suspension or the plate incorporation assay yielded a positive mutagenic response. This information was combined to indicate the change in mutagenic activity in the raw water and water from distribution points I and II as compared with the mutagenic activity of the finished water.

The summary of the data in Tables 6 and 7 indicates in general that the distribution system neither adds nor substracts from the mutagenicity present in the finished water, in any consistent manner. The types of pipes used in these water systems included cast/ductile iron, cement-lined steel and asbestos/cement pipes. The water systems which indicated either an increase or decrease in mutagenic activity during distribution represented all the various types of pipes. Thus, the data suggest that, although in some cases the mutagenic activity of finished water may be affected by the distribution system, this effect cannot be simply be attributed solely to the type of pipe used to transport the water.

A further indication of the complexity of the interaction of compounds in drinking water with the distribution pipes is demonstrated in the two water supplies which were tested twice. The sample obtained from the first trip to Champaign was only tested in a limited manner for mutagenic activity, with only a single concentration of the organic concentrate tested. This limited assay produced over a five fold increase in the reversion rate for TA98 in the presence of metabolic activation at the two distribution points. This result contrasts with the finding of no mutagenic activity in this strain with samples of raw water and finished water. Upon collecting and assaying a new water sample from Champaign the total mutagenic response was considerably lower, and this low level of activity was observed in samples from all collection points. In testing two independent samples from Ft. Myers similar results were obtained. The first samples showed a decrease in mutagenic activity in water obtained from the distribution system while the second indicated that the distribution system had no effect on mutagenic activity. The distribution lines were the same for the two trips to Champaign, however, different pipes were tested during the two trips to Ft. Myers.

Some of the variables which may affect the mutagenic activity in drinking water, and the interaction of this activity with the distribution pipes include variation in raw water quality, treatment processes in the preparation of finished water, and differences in the microbiological population in the pipes. The first two variables can cause qualitative changes in the trace organic content of the finished water. If these changes generate different mutagens or promutagens it might not be unexpected that different types of interaction with the distribution system may occur. Also, changes in the raw water quality and treatment processes may alter the pH of the water, the chlorine content, and the amount of disolved and suspended solids. Any of these changes could affect the ability of the water to leach material from the distribution pipe, or may affect the biological

activity of leached compounds. Finally, Alexander (1974) has reported the synthesis of mutagens by microbiological action, and if this is occurring in the distribution lines then changes in the microbiological population will cause changes in the patterns of mutagenicity.

It is difficult from the results of the present study to speculate on whether any of the above processes could account for the different results obtained from the two water samples taken from Champaign and Fort Myers. However, a recent report by Clark and Johnston (1981) describes an extensive analysis of the mutagenic activity in the drinking water of Champaign. In this study not only was marked seasonal variation was observed which may be related to the fact that Champaign has two separate water supplies which are used at different times of the year. A correlation was, also, made between mutagenic activity and the alternating use of chloramine and break-point chlorination in the treatment processes. In a similar manner those changes in the treatment processes could account for both the quantitative differences in mutagenic activity and the differences in the patterns of mutagenic activity observed by us in the two sampling trips to Champaign. There is no information on what caused the differences in mutagenicity in the Ft. Myers samples except that during the second trip there was a severe drought condition which resulted in poor water quality as measured by total organic carbon levels.

PAH, many of which are mutagenic (Santodonato et al., 1979), were detected in most of the water samples. Although mutagenic PAH were present, the concentration of PAH did not correlate with the level of mutagenic activity. The range of mutagenic response included ratios of 1.51 to 4.13 for samples which contained no detectable levels of the six representative PAH. The highest mutagenic activity was observed in Champaign (first trip) even though the total PAH concentration was only 6.2 ng, whereas the sample from Wheeling had the highest PAH level, 1586 ng/ℓ, but produced no demonstrable mutagenic activity. It is also important to note that PAH require metabolic activation before mutagenicity can be observed in the Ames assay, and a number of water systems showed mutagenic activity in the absence of metabolic activation. Although the PAH either present in the raw water or leached from distribution pipes may contribute to some of the mutagenic response observed, this cannot be the major source of biological activity in the sample. Also, it is clear that the levels of PAH would be a poor indicator of the overall mutagenic potential of drinking waters examined in this study.

The results of this study indicate that the mutagenic compounds present in drinking water represent a diverse group of contaminants when the water supplies are compared with each other. As can be determined from an examination of the mutagenicity data in Appendix A most of the positive results were obtained with the plate incorporation assay, however, at least some of the positive responses were observed in the liquid suspension assay. The starting material for the adsorbed and eluted from polyurethane foam plugs. The compounds adsorbed to polyurethane foam plugs probably represent relatively hydrophobic compounds, whereas the unconcentrated water containing both polar and nonpolar compounds, was assayed only with the plate incorporation technique. The presence of mutagenic activity in only one assay system is suggestive evidence that the mutagens are predominantly polar (plate incorporation assay) or nonpolar (liquid sus-

pension assay) compounds. Some of the water supplies appear to have mutagens which do not adsorb to polyurethane foam plugs while others have mutagens which could be concentrated by this technique.

The second indication that the mutagens in drinking water represent a diverse group of compounds is the varying requirement for metabolic activation for expression of mutagenicity. Mammalian metabolic activation (i.e., S-9 mix) is needed to convert pro-mutagens to ultimate mutagens in the Ames assay. As shown in Table 7 some water supplies displayed mutagenic activity only in the presence of S-9 mix, indicating that only pro-mutagens were present while other supplies revealed the presence of ultimate mutagens exclusively, as indicated by activity only in the absence of S-9. The absence in these cases of activity in the presence of S-9 indicates that mammalian enzymes present in the S-9 mix are capable of metabolizing the ultimate mutagens to inactive compounds. In samples where activity is present both with and without metabolic activation it is impossible to say whether both ultimate and pro-mutagens are present or that the ultimate mutagens are refractory to mammalian metabolism. The above evidence suggests that a number of classes of compounds may be responsible for the mutagenic activity observed in the water supplies tested in this study.

Along with attempts to detect the effect of the distribution system on mutagenic activity of drinking waters, this study also provides additional information on the efficiency of removal of mutagens by water treatment, and on the presence of mutagens in raw waters. One of the earliest reports which described mutagenic activity in raw water was the study of Pelon et al. (1977). The water tested was from the Mississippi River which receives wastewater from a large number of industries. Pelon et al. (1977) used unconcentrated raw water in their study while in a more recent investigation, Kool et al. (1981a) observed mutagenic activity in organic concentrates from surface waters in the Netherlands. In the present study 12 of the 24 raw waters tested displayed detectable mutagenic activity (Table 8). It is of interest to note that most of the locations showing mutagenic activity received their raw water from surface water sources, while most of the ground waters tested in this study showed no mutagenic activity. The presence of pollutants in surface waters is well documented, with the pollution occurring primarily from intentional discharge, atmospheric fallout, and ground run off. On the other hand, filtration through sand has long been used to purify water, and this type of filtration along with biological degradation which would naturally occur prior to water entering the aquifer probably accounts for the general lack of activity shown in ground water. Page (1981) stated that soil is effective in removing contaminates from surface water prior to their entry into ground water; although, saturation of the adsorptive capacity of soil can allow appreciable contamination of ground water. Page (1981) showed that some halogenated compounds were present in ground water at the same levels as surface water in the highly industrialized state of New Jersey.

The presence of mutagens in drinking water has also been well documented (Kool et al., 1981b, 1981c; Loper et al., 1978; Schwartz et al., 1979; Simmon et al., 1977). As can be seen in Table 7 we found in many cases the water after treatment was more mutagenic than the raw water. In three of the water systems we tested the raw water was nonmutagenic while the finished water contained some

Table 8. Comparison of Mutagenic Activity in Raw Water with the Type of Raw Source

Mutagenic Activity Present in Raw Water		Mutagenic Activity Not Present in Raw Water	
Location of Water Supply	Source of Raw Water	Location of Water Supply	Source of Raw Water
Appleton	Lake	Billings	River
Augusta	River	Eau Clair	Ground Water
Austin	Lake	Elkhart	Ground Water
Champaign	Ground Water	Fayetteville	River
Fairborn	Ground Water	Fond du Lac	Ground Water
Fort Meyers	River	Hutchinson	Ground Water
Fort Mitchell	River	Iowa City	River
Fremont	River	La Cross	Ground Water
Nampa	River	Tuscaloosa	River
Olympia	Ground Water	Wheeling	River
Wichita Falls	Lake	Merced	Ground Water
Yakima	River	San Luis Obispo	Lake

mutagenic activity. A number of studies have linked the mutagenic activity in drinking water to the formation of low molecular weight chlorinated compounds produced by chlorination (Simmon et al., 1977; Rapson et al., 1980; Brett and Calverly, 1979; Dolara et al., 1981; Anonymous, 1981). Although chlorination may be the source of the increased mutagenicity observed in finished water, the activity probably did not result from chlorinated low molecular weight compounds, since neither of the assay procedures used in this study are very effective at the detection of volatile compounds. In addition to chlorination, mutagens may also be added to finished water through the presence of trace contaminants in the chemicals used during purification (e.g., lime addition). Without more extensive investigation of each process employed in the purification of drinking waters we studied the specific source of the increase in mutagenic activity cannot be determined. Table 7 also shows that in two cases the treatment process was effective in the removal of mutagenic activity, while in six cases the treatment had no effect on the level of mutagens.

Many of the samples tested, including both finished water and distributed water, exhibited low levels of mutagenic activity (Appendix A). The implication to human health of these low levels of mutagenic activity are not fully understood at the present. This is particularly true in the assessment of mutagenic activity in complex environmental mixtures in which a large number of interactions may occur. Supression of mutagenic activity has been observed in other environmental samples as a result of interactions (Shahn and Fournier, 1978). Although enhancement of activity has not been reported there have been no systematic investigations of the performance of the Ames assay with complex environmental mixtures. The interpretation of mutagenicity is further complicated by the low levels of activity commonly observed in water samples and the toxicity to the bacteria of the organic concentrates which prevent the use of high dose levels. Overall the results obtained with the Ames assay in this study indicate that some drinking water suplies contain compounds that have potential biological activity. The presence of biologically active compounds in drinking water indicate that these water supplies should be first studied in greater detail to determine the source of this contamination before attempting to assess any public health arising from the consumption of this water.

SECTION 7

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APPENDIX A

Mutagenic Activity in Drinking Waters

Key to Tables 1-131:

[1]Metabolic Activation = rat liver S-9 homogenate/extract for enzymatic activation is present (+) or absent (-)

[2]Dose: C = control; L = low; M = medium; X = intermediate; H = high

[3]Dose: C = control; 1 ml = 1 ml of filter sterilized water per plate, 1/2 = equal volumes of media water and distilled water used in preparing agar; Full = only filter sterilized media water used to prepare agar

*Weak mutagenic response indicated; **Mutagenic response indicated

NA = not applicable; NC = Not calculated; NT = not tested; SD = standard deviation

Table 1. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Appleton, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	HS	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	91.0	NT	NT	NT	83.0	Mean	39.2	82.4	43.8	50.8	7.1
		SD	NA	NT	NT	NT	0.91	SD	4.2	10.4	8.6	4.6	
		ratio						ratio	NA	2.10**	1.18	1.30	
	-	Mean	70.5	NT	NT	NT	44.0	Mean	40.4	41.0	51.4	48.4	
		ratio	NA	NT	NT	NT	0.62	SD	7.2	3.9	9.2	3.1	
								ratio	NA	1.02	1.27	1.20	
Finished water	+	Mean	91.0	NT	NT	NT	83.5	Mean	39.2	78.8	61.6	61.2	6.1
		ratio	NA	NT	NT	NT	0.92	SD	4.2	8.1	4.1	7.8	
								ratio	NA	2.01**	1.57*	1.56*	
	-	Mean	70.5	NT	NT	NT	32.0	Mean	40.4	40.4	38.0	48.2	
		ratio	NA	NT	NT	NT	0.45	SD	7.2	9.6	13.8	13.0	
								ratio	NA	1.00	0.94	1.19	
Dist. I	+	Mean	91.0	NT	NT	NT	90.5	Mean	39.2	100.4	72.4	75.8	7.8
		ratio	NA	NT	NT	NT	0.99	SD	4.2	12.5	3.6	5.9	
								ratio	NA	2.56**	1.85*	1.93*	
	-	Mean	70.5	NT	NT	NT	46.5	Mean	40.4	48.6	47.4	60.2	
		ratio	NA	NT	NT	NT	0.66	SD	7.2	4.6	4.9	6.1	
								ratio	NA	1.20	1.17	1.49	
Dist. II	+	Mean	91.0	NT	NT	NT	77.0	Mean	39.2	92.8	55.2	64.0	18.0
		ratio	NA	NT	NT	NT	0.85	SD	4.2	9.9	4.7	11.9	
								ratio	NA	2.37**	1.41	1.63*	
	-	Mean	70.5	NT	NT	NT	35.5	Mean	40.4	44.0	29.8	34.6	
		ratio	NA	NT	NT	NT	0.50	SD	7.2	8.1	2.9	6.5	
								ratio	NA	1.09	0.74	0.86	

Table 2. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Appleton, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	133.8	112.6	165.4	284.2	7.1
		ratio	NT	NT	NT	NT	NT	SD	9.5	13.4	9.4	44.2	
								ratio	NA	0.84	1.24	2.12**	
	-	Mean	NT	NT	NT	NT	NT	Mean	207.8	211.2	378.2	366.8	
		ratio	NT	NT	NT	NT	NT	SD	16.0	16.5	30.2	21.3	
								ratio	NA	1.02	1.82*	1.77*	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	133.8	129.2	173.0	240.2	6.1
		ratio	NT	NT	NT	NT	NT	SD	9.5	11.3	33.8	42.2	
								ratio	NA	0.97	1.29	1.80*	
	-	Mean	NT	NT	NT	NT	NT	Mean	207.8	202.2	227.4	275.8	
		ratio	NT	NT	NT	NT	NT	SD	16.0	12.3	33.7	37.0	
								ratio	NA	0.96	1.09	1.33	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	133.8	118.4	205.2	388.6	7.8
		ratio	NT	NT	NT	NT	NT	SD	9.5	16.8	38.8	10.0	
								ratio	NA	0.89	1.53*	2.90**	
	-	Mean	NT	NT	NT	NT	NT	Mean	207.8	185.2	350.2	415.2	
		ratio	NT	NT	NT	NT	NT	SD	16.0	32.0	32.6	18.6	
								ratio	NA	0.89	1.69*	2.00**	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	133.8	144.6	156.4	302.4	18.0
		ratio	NT	NT	NT	NT	NT	SD	9.5	22.6	21.2	21.3	
								ratio	NA	1.08	1.17	2.26**	
	-	Mean	NT	NT	NT	NT	NT	Mean	207.8	215.6	229.8	358.8	
		ratio	NT	NT	NT	NT	NT	SD	16.0	25.9	16.5	42.9	
								ratio	NA	1.04	1.11	1.73*	

Table 3. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Appleton, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	40.5	NT	NT	NT	31.0	Mean	37.0	49.0	55.6	56.6	7.1
		ratio	NA	NT	NT	NT	0.77	SD	5.3	6.1	9.8	4.0	
								ratio	NA	1.32	1.50*	1.53*	
	-	Mean	121.0	NT	NT	NT	96.0	Mean	69.6	80.4	115.0	116.2	
		ratio	NA	NT	NT	NT	0.79	SD	14.0	6.0	11.2	12.8	
								ratio	NA	1.16	1.65*	1.67*	
Finished water	+	Mean	40.5	NT	NT	NT	30.5	Mean	37.0	41.2	67.4	69.4	6.1
		ratio	NA	NT	NT	NT	0.75	SD	5.3	8.2	3.3	3.9	
								ratio	NA	1.11	1.82*	1.88*	
	-	Mean	121.0	NT	NT	NT	85.0	Mean	69.6	78.4	103.2	106.2	
		ratio	NA	NT	NT	NT	0.70	SD	14.0	5.9	18.7	14.8	
								ratio	NA	1.13	1.48	1.53*	
Dist. I	+	Mean	40.5	NT	NT	NT	36.0	Mean	37.0	45.4	80.2	57.0	7.8
		ratio	NA	NT	NT	NT	0.89	SD	5.3	7.1	11.7	15.5	
								ratio	NA	1.23	2.17**	1.54*	
	-	Mean	121.0	NT	NT	NT	74.0	Mean	69.6	72.2	105.2	115.2	
		ratio	NA	NT	NT	NT	0.61	SD	14.0	12.4	13.8	12.0	
								ratio	NA	1.04	1.51*	1.66*	
Dist. II	+	Mean	40.5	NT	NT	NT	36.0	Mean	37.0	53.2	55.8	69.2	18.0
		ratio	NA	NT	NT	NT	0.89	SD	5.3	11.1	4.1	15.4	
								ratio	NA	1.44	1.51*	1.87*	
	-	Mean	121.0	NT	NT	NT	95.5	Mean	69.6	84.4	115.2	97.0	
		ratio	NA	NT	NT	NT	0.79	SD	14.0	11.9	14.1	15.9	
								ratio	NA	1.21	1.66*	1.39	

Table 4. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Appleton, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	31.4	35.4	24.6	29.8	7.1
		ratio	NT	NT	NT	NT	NT	SD	6.3	4.8	2.2	7.3	
								ratio	NA	1.13	0.78	0.95	
	-	Mean	NT	NT	NT	NT	NT	Mean	12.0	14.2	18.2	20.4	
		ratio	NT	NT	NT	NT	NT	SD	7.1	3.1	3.6	2.5	
								ratio	NA	1.18	1.52*	1.70*	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	31.4	42.2	30.0	28.8	6.1
		ratio	NT	NT	NT	NT	NT	SD	6.3	8.7	5.0	6.7	
								ratio	NA	1.34	0.96	0.92	
	-	Mean	NT	NT	NT	NT	NT	Mean	12.0	7.2	16.2	19.4	
		ratio	NT	NT	NT	NT	NT	SD	7.1	1.5	2.9	4.3	
								ratio	NA	0.6	1.35	1.62*	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	31.4	41.4	29.6	25.0	7.8
		ratio	NT	NT	NT	NT	NT	SD	6.3	5.6	5.5	4.2	
								ratio	NA	1.32	0.94	0.80	
	-	Mean	NT	NT	NT	NT	NT	Mean	12.0	14.2	16.8	14.8	
		ratio	NT	NT	NT	NT	NT	SD	7.1	4.3	3.3	4.3	
								ratio	NA	1.18	1.40	1.23	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	31.4	41.2	31.4	25.4	18.0
		ratio	NT	NT	NT	NT	NT	SD	6.3	6.4	4.0	9.0	
								ratio	NA	1.31	1.00	0.81	
	-	Mean	NT	NT	NT	NT	NT	Mean	12.0	10.2	16.2	15.6	
		ratio	NT	NT	NT	NT	NT	SD	7.1	2.4	4.0	3.1	
								ratio	NA	0.85	1.35	1.30	

Table 5. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Appleton, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Number of Revertants per Plate										PNA ng/ℓ
		Liquid Suspension Assay						Plate Incorporation Assay				
		Parameter	Dose[2] C	L	M	X	H	Parameter	Dose[3] C	1 mℓ	1/2	Full	
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	79.8	83.4	68.6	73.8	7.1
		ratio	NT	NT	NT	NT	NT	SD	8.5	19.7	4.6	5.1	
								ratio	NA	1.05	0.86	0.93	
	-	Mean	NT	NT	NT	NT	NT	Mean	35.8	32.8	42.8	52.4	
		ratio	NT	NT	NT	NT	NT	SD	5.5	5.9	8.6	4.0	
								ratio	NA	0.92	1.20	1.46	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	79.8	58.2	63.6	78.8	6.1
		ratio	NT	NT	NT	NT	NT	SD	8.5	11.4	3.8	7.3	
								ratio	NA	0.73	0.80	0.99	
	-	Mean	NT	NT	NT	NT	NT	Mean	35.8	29.0	38.6	39.0	
		ratio	NT	NT	NT	NT	NT	SD	5.5	7.0	8.0	5.0	
								ratio	NA	0.81	1.08	1.09	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	79.8	71.2	70.6	69.8	7.8
		ratio	NT	NT	NT	NT	NT	SD	8.5	7.4	8.2	12.4	
								ratio	NA	0.89	0.89	0.88	
	-	Mean	NT	NT	NT	NT	NT	Mean	35.8	36.8	37.6	50.2	
		ratio	NT	NT	NT	NT	NT	SD	5.5	7.5	6.3	4.2	
								ratio	NA	1.03	1.05	1.40	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	79.8	60.8	53.2	75.6	18.0
		ratio	NT	NT	NT	NT	NT	SD	8.5	11.4	6.8	9.8	
								ratio	NA	0.76	0.67	0.95	
	-	Mean	NT	NT	NT	NT	NT	Mean	35.8	32.4	34.6	48.8	
		ratio	NT	NT	NT	NT	NT	SD	5.5	4.3	4.0	7.0	
								ratio	NA	0.91	0.97	1.36	

Table 6. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Augusta, Georgia. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA
Raw water	+	Mean	42.0	36.0	32.0	NT	35.5	Mean	45.8	54.8	60.2	63.0	0.1
		ratio	NA	0.86	0.76	NT	0.85	SD	7.12	3.74	9.6	10.4	
								ratio	NA	1.97*	1.31	1.38	
	-	Mean	35.5	27.0	28.0	NT	26.0	Mean	44.0	49.4	42.8	49.0	
		ratio	NA	0.76	0.79	NT	0.73	SD	9.10	5.4	5.5	11.7	
								ratio	NA	1.12	0.97	1.11	
Finished water	+	Mean	42.0	31.5	47.5	NT	40.5	Mean	45.8	50.0	59.0	63.4	3.2
		ratio	NA	0.75	1.13	NT	0.96	SD	7.12	10.8	6.2	7.9	
								ratio	NA	1.09	1.29	1.38	
	-	Mean	35.5	43.0	33.5	NT	35.0	Mean	44.0	47.4	45.0	51.0	
		ratio	NA	1.21	0.94	NT	0.99	SD	9.10	10.7	6.4	5.6	
								ratio	NA	1.08	1.02	1.16	
Dist. I	+	Mean	42.0	35.0	35.5	NT	34.0	Mean	45.8	56.4	53.4	58.8	ND
		ratio	NA	0.83	0.85	NT	0.81	SD	7.12	7.4	4.7	3.6	
								ratio	NA	1.23	1.17	1.28	
	-	Mean	35.0	26.0	31.0	NT	37.0	Mean	44.0	51.8	50.6	47.4	
		ratio	NA	0.73	0.87	NT	1.04	SD	9.10	17.6	6.6	5.4	
								ratio	NA	1.18	1.15	1.08	
Dist. II	+	Mean	42.0	28.5	31.0	NT	29.0	Mean	45.8	48.2	48.4	55.4	ND
		ratio	NA	0.68	0.74	NT	0.69	SD	7.12	4.0	11.9	7.0	
								ratio	NA	1.05	1.06	1.21	
	-	Mean	35.0	32.0	31.5	NT	34.5	Mean	44.0	50.8	45.0	42.6	
		ratio	NA	0.90	0.89	NT	0.97	SD	9.10	6.5	7.8	8.1	
								ratio	NA	1.16	1.02	0.97	

Table 7. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Augusta, Georgia. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	253.0	223.0	219.5	NT	177.5	Mean	251.0	213.6	227.6	239.6	0.1
		ratio	NA	0.88	0.87	NT	0.70	SD	22.7	23.2	15.2	13.0	
								ratio	NA	0.85	0.91	0.96	
	-	Mean	275.0	223.0	207.5	NT	276.5	Mean	191.4	214.4	230.0	227.2	
		ratio	NA	0.81	0.87	NT	1.01	SD	20.7	13.7	19.3	22.1	
								ratio	NA	1.12	1.20	1.19	
Finished water	+	Mean	253.0	235.0	227.0	NT	221.0	Mean	251.0	221.6	245.2	259.4	3.2
		ratio	NA	0.93	0.90	NT	0.87	SD	22.7	9.8	15.4	20.6	
								ratio	NA	0.88	0.98	1.03	
	-	Mean	275.0	298.5	287.5	NT	268.0	Mean	191.4	193.8	218.2	252.8	
		ratio	NA	1.09	1.01	NT	0.97	SD	20.7	16.1	17.5	21.1	
								ratio	NA	1.01	1.14	1.32	
Dist. I	+	Mean	253.0	218.5	206.5	NT	202.5	Mean	251.0	229.4	248.8	246.0	ND
		ratio	NA	0.86	0.82	NT	0.80	SD	22.7	32.5	16.5	28.1	
								ratio	NA	0.91	0.99	0.98	
	-	Mean	275.0	265.0	258.5	NT	270.5	Mean	191.4	202.4	237.6	245.0	
		ratio	NA	0.96	0.94	NT	0.98	SD	20.7	19.5	25.3	18.9	
								ratio	NA	1.06	1.24	1.28	
Dist. II	+	Mean	253.0	246.0	251.5	NT	258.5	Mean	251.0	234.6	241.2	242.6	ND
		ratio	NA	0.97	0.99	NT	1.02	SD	22.7	39.8	13.9	12.0	
								ratio	NA	0.94	0.96	0.97	
	-	Mean	275.0	252.5	285.0	NT	246.5	Mean	191.4	214.0	234.8	219.8	
		ratio	NA	0.92	1.04	NT	0.90	SD	20.7	25.0	9.6	12.2	
								ratio	NA	1.12	1.23	1.15	

Table 8. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Augusta, Georgia. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate — Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	38.0	25.0	31.0	NT	30.5	Mean	52.8	76.6	76.6	67.8	0.1
		SD						SD	3.1	11.2	14.9	11.0	
		ratio	NA	0.66	0.82	NT	0.80	ratio	NA	1.45	1.45	1.28	
	-	Mean	47.0	51.0	37.5	NT	56.5	Mean	48.8	69.8	77.2	79.2	
		SD						SD	6.2	23.3	9.7	9.9	
		ratio	NA	1.09	0.80	NT	1.20	ratio	NA	1.43	1.58*	1.62*	
Finished water	+	Mean	38.0	23.0	34.0	NT	28.5	Mean	52.8	68.0	78.4	64.6	3.2
		SD						SD	3.1	13.7	8.7	11.6	
		ratio	NA	0.61	0.89	NT	0.75	ratio	NA	1.29	1.49	1.22	
	-	Mean	47.0	35.5	60.5	NT	65.0	Mean	46.8	65.6	67.2	76.4	
		SD						SD	6.2	7.1	7.1	10.9	
		ratio	NA	0.76	1.29	NT	1.38	ratio	NA	1.34	1.38	1.57*	
Dist. I	+	Mean	38.0	46.0	39.0	NT	36.5	Mean	52.8	62.0	61.8	63.8	ND
		SD						SD	3.1	16.1	7.8	21.1	
		ratio	NA	1.21	1.03	NT	0.96	ratio	NA	1.17	1.17	1.21	
	-	Mean	47.0	57.5	56.5	NT	63.5	Mean	48.8	74.6	71.6	85.6	
		SD						SD	6.2	8.0	9.8	7.3	
		ratio	NA	1.22	1.20	NT	1.35	ratio	NA	1.53*	1.47	1.75*	
Dist. II	+	Mean	38.0	27.5	31.0	NT	35.0	Mean	52.8	66.4	67.0	70.4	ND
		SD						SD	3.1	7.7	10.2	8.5	
		ratio	NA	0.72	0.82	NT	0.92	ratio	NA	1.26	1.27	1.33	
	-	Mean	47.0	46.0	72.0	NT	60.0	Mean	48.8	61.2	67.0	75.4	
		SD						SD	6.2	16.8	9.5	10.5	
		ratio	NA	0.98	1.53*	NT	1.28	ratio	NA	1.25	1.37	1.55*	

Table 9. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Augusta, Georgia. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	14.2	7.2	7.2	7.0	0.1
		ratio	NT	NT	NT	NT	NT	SD	5.0	3.3	0.8	3.1	
								ratio	NA	0.51	0.51	0.49	
	-	Mean	NT	NT	NT	NT	NT	Mean	5.6	7.4	8.6	4.4	
		ratio	NT	NT	NT	NT	NT	SD	2.0	1.5	4.0	1.1	
								ratio	NA	1.32	1.54*	0.79	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	14.2	7.6	5.4	5.4	3.2
		ratio	NT	NT	NT	NT	NT	SD	5.0	2.7	2.1	3.8	
								ratio	NA	0.54	0.38	0.38	
	-	Mean	NT	NT	NT	NT	NT	Mean	5.6	5.6	6.6	7.2	
		ratio	NT	NT	NT	NT	NT	SD	2.0	3.4	4.9	4.4	
								ratio	NA	1.0	1.18	1.29	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	14.2	9.0	10.6	8.2	ND
		ratio	NT	NT	NT	NT	NT	SD	5.0	5.2	4.6	4.0	
								ratio	NA	0.63	0.75	0.58	
	-	Mean	NT	NT	NT	NT	NT	Mean	5.6	6.4	9.0	9.4	
		ratio	NT	NT	NT	NT	NT	SD	2.0	1.5	2.9	4.0	
								ratio	NA	1.14	1.60*	1.68*	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	14.2	7.8	6.4	6.2	ND
		ratio	NT	NT	NT	NT	NT	SD	5.0	2.7	2.7	1.8	
								ratio	NA	0.55	0.45	0.44	
	-	Mean	NT	NT	NT	NT	NT	Mean	5.6	5.6	7.2	6.0	
		ratio	NT	NT	NT	NT	NT	SD	2.0	1.5	2.3	1.0	
								ratio	NA	1.0	1.29	1.07	

Table 10. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Augusta, Georgia. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	35.0	43.5	37.5	NT	19.5	Mean	41.8	26.4	56.0	48.2	0.1
		SD						SD	8.8	6.5	12.9	12.7	
		ratio	NA	1.24	1.07	NT	0.56	ratio	NA	0.63	1.34	1.15	
	-	Mean	20.5	22.5	22.5	NT	34.5	Mean	28.0	28.2	60.2	43.6	
		SD						SD	3.0	6.7	6.4	12.1	
		ratio	NA	1.10	1.10	NT	1.68	ratio	NA	1.01	2.15**	1.56*	
Finished water	+	Mean	35.0	34.5	19.5	NT	34.5	Mean	41.8	34.0	37.2	36.8	3.2
		SD						SD	8.8	6.8	9.6	17.0	
		ratio	NA	0.99	0.56	NT	0.99	ratio	NA	0.81	0.89	0.88	
	-	Mean	20.5	30.5	28.0	NT	30.0	Mean	28.0	19.0	29.2	27.2	
		SD						SD	3.0	2.4	8.8	8.3	
		ratio	NA	1.49	1.37	NT	1.46	ratio	NA	0.68	1.04	0.97	
Dist. I	+	Mean	35.0	29.0	33.5	NT	30.5	Mean	41.8	37.2	42.0	34.6	ND
		SD						SD	8.8	8.9	11.4	6.7	
		ratio	NA	0.83	0.96	NT	0.87	ratio	NA	0.89	1.00	0.83	
	-	Mean	20.5	18.5	28.5	NT	40.5	Mean	28.0	27.8	24.6	27.6	
		SD						SD	3.0	1.9	4.0	14.6	
		ratio	NA	0.90	1.39	NT	1.98*	ratio	NA	0.99	0.88	0.99	
Dist. II	+	Mean	35.0	37.5	33.5	NT	27.5	Mean	41.8	36.8	35.4	36.0	ND
		SD						SD	8.8	5.1	4.7	6.6	
		ratio	NA	1.06	0.96	NT	0.76	ratio	NA	0.88	0.85	0.86	
	-	Mean	20.5	22.5	28.5	NT	31.0	Mean	28.0	27.8	33.6	26.0	
		SD						SD	3.0	4.6	7.5	1.9	
		ratio	NA	1.10	1.39	NT	1.51*	ratio	NA	0.99	1.2	0.93	

Table 11. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Austin, Texas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	68.0	72.5	51.5	85.0	72.5	Mean	68.2	71.4	67.2	69.0	18.3
		SD						SD	11.4	5.7	9.2	19.6	
		ratio	NA	1.07	0.76	1.25	1.07	ratio	NA	1.05	0.99	1.01	
	-	Mean	48.0	47.0	68.5	75.5	109.0	Mean	49.8	50.0	59.4	57.8	
		SD						SD	13.0	9.9	5.9	7.7	
		ratio	NA	0.98	1.43	1.57*	2.27**	ratio	NA	1.00	1.19	1.16	
Finished water	+	Mean	68.0	67.0	70.0	63.5	79.0	Mean	68.2	79.2	78.8	61.4	8.3
		SD						SD	11.4	14.7	8.3	7.2	
		ratio	NA	0.98	1.02	0.93	1.16	ratio	NA	1.16	1.56*	0.90	
	-	Mean	48.0	80.0	77.5	64.0	83.5	Mean	49.8	63.8	61.0	63.0	
		SD						SD	13.0	1.48	5.2	2.1	
		ratio	NA	1.67*	1.61*	1.33	1.74*	ratio	NA	1.28	1.22	1.27	
Dist. I	+	Mean	68.0	72.0	65.0	71.0	56.0	Mean	68.2	82.2	75.8	91.0	0.5
		SD						SD	11.4	7.2	12.7	17.0	
		ratio	NA	1.05	0.96	1.04	0.82	ratio	NA	1.21	1.11	1.33	
	-	Mean	48.0	89.0	73.5	74.0	101.5	Mean	49.8	72.4	66.4	63.6	
		SD						SD	13.0	4.7	10.9	10.6	
		ratio	NA	1.85*	1.53*	1.54*	2.11**	ratio	NA	1.45	1.33	1.28	
Dist. II	+	Mean	68.0	71.0	69.5	77.0	85.0	Mean	68.2	95.8	75.2	63.4	2.1
		SD						SD	11.4	6.1	10.6	7.1	
		ratio	NA	1.04	1.02	1.13	1.25	ratio	NA	1.41	1.10	0.93	
	-	Mean	48.0	82.0	73.0	72.5	91.0	Mean	49.8	77.4	61.2	60.4	
		SD						SD	13.0	8.9	10.6	4.0	
		ratio	NA	1.71*	1.52*	1.51*	1.90*	ratio	NA	1.55*	1.23	1.21	

Table 12. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Austin, Texas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 ml	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	403.5	418.5	420.5	387.0	420.5	Mean	295.0	275.0	264.0	283.8	18.3
		SD						SD	45.3	10.1	20.0	34.0	
		ratio	NA	1.04	1.04	0.96	1.04	ratio	NA	0.93	0.90	0.96	
	-	Mean	299.5	341.0	315.0	343.0	346.5	Mean	309.6	257.0	208.6	229.2	
		SD						SD	44.4	42.3	10.2	11.1	
		ratio	NA	1.14	1.05	1.15	1.16	ratio	NA	0.83	0.67	0.74	
Finished water	+	Mean	403.5	453.5	408.5	413.5	428.0	Mean	295.0	266.4	267.6	296.4	8.3
		SD						SD	45.3	14.0	29.7	35.1	
		ratio	NA	1.12	1.01	1.10	1.06	ratio	NA	0.90	0.91	1.00	
	-	Mean	299.5	367.5	293.0	313.5	345.0	Mean	309.6	285.4	250.6	267.4	
		SD						SD	44.4	40.4	18.5	8.4	
		ratio	NA	1.23	0.98	1.05	1.15	ratio	NA	0.92	0.81	0.86	
Dist. I	+	Mean	403.5	403.0	415.5	412.0	432.0	Mean	295.0	314.4	285.8	301.4	0.5
		SD						SD	45.3	32.3	21.3	14.9	
		ratio	NA	1.00	1.03	1.02	1.07	ratio	NA	1.07	0.97	1.02	
	-	Mean	299.5	309.0	286.5	310.0	311.0	Mean	309.6	320.8	275.0	265.0	
		SD						SD	44.4	30.8	24.7	23.7	
		ratio	NA	1.03	0.96	1.04	1.04	ratio	NA	1.04	0.89	0.86	
Dist. II	+	Mean	403.5	419.0	398.0	423.5	425.5	Mean	295.0	312.2	313.2	289.8	2.1
		SD						SD	45.3	14.5	15.9	30.4	
		ratio	NA	1.04	0.99	1.05	1.05	ratio	NA	1.06	1.06	0.98	
	-	Mean	299.5	305.0	307.0	324.5	317.5	Mean	309.6	324.8	259.0	266.8	
		SD						SD	44.4	11.1	26.2	31.3	
		ratio	NA	1.02	1.03	0.80	1.06	ratio	NA	1.05	0.84	0.86	

Table 13. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Austin, Texas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	34.0	35.5	25.5	43.5	41.0	Mean	75.6	69.6	81.0	82.8	18.3
		SD						SD	12.9	10.3	6.0	18.5	
		ratio	NA	1.04	0.75	1.28	1.20	ratio	NA	0.92	1.07	1.10	
	-	Mean	69.5	78.5	71.0	89.0	73.5	Mean	58.8	58.8	65.2	66.4	
		SD						SD	11.6	10.3	11.0	6.7	
		ratio	NA	1.13	1.02	1.28	1.06	ratio	NA	1.00	1.11	1.13	
Finished water	+	Mean	34.0	25.5	37.5	42.5	33.5	Mean	75.6	65.2	83.4	87.4	8.3
		SD						SD	12.9	3.1	7.8	9.8	
		ratio	NA	0.75	1.10	1.25	0.98	ratio	NA	0.86	1.10	1.16	
	-	Mean	69.5	72.0	75.5	42.5	78.5	Mean	58.8	75.2	76.4	80.2	
		SD						SD	11.6	14.0	9.2	10.2	
		ratio	NA	1.04	1.09	0.61	1.13	ratio	NA	1.28	1.30	1.36	
Dist. I	+	Mean	34.0	29.5	42.0	38.5	33.0	Mean	75.6	51.6	86.0	79.2	0.5
		SD						SD	12.9	3.8	11.0	16.9	
		ratio	NA	0.87	1.24	1.13	0.97	ratio	NA	0.68	1.14	1.05	
	-	Mean	69.5	76.0	100.5	44.5	82.5	Mean	58.8	69.0	71.0	70.8	
		SD						SD	11.6	6.0	14.1	10.8	
		ratio	NA	1.09	1.45	0.64	1.19	ratio	NA	1.17	1.21	1.20	
Dist. II	+	Mean	34.0	34.5	38.5	42.0	38.5	Mean	75.6	67.8	85.2	75.0	2.1
		SD						SD	12.9	9.5	11.4	13.4	
		ratio	NA	1.01	1.13	1.24	1.13	ratio	NA	0.90	1.13	0.99	
	-	Mean	69.5	68.0	78.0	40.5	80.0	Mean	58.8	70.2	75.0	78.6	
		SD						SD	11.6	9.7	6.5	1.1	
		ratio	NA	0.98	1.12	0.58	1.15	ratio	NA	1.19	1.28	1.34	

Table 14. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Austin, Texas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	27.0	20.4	7.6	11.0	18.3
		ratio	NT	NT	NT	NT	NT	SD	6.2	4.0	3.2	3.5	
								ratio	NA	0.76	0.28	0.41	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.2	8.6	11.4	16.2	
		ratio	NT	NT	NT	NT	NT	SD	5.0	3.2	3.9	2.6	
								ratio	NA	0.50	0.66	0.94	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	27.0	8.0	5.2	7.2	8.3
		ratio	NT	NT	NT	NT	NT	SD	6.2	2.8	2.3	2.9	
								ratio	NA	0.30	0.19	0.27	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.2	8.2	9.0	10.2	
		ratio	NT	NT	NT	NT	NT	SD	5.0	3.3	2.6	2.7	
								ratio	NA	0.48	0.52	0.59	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	27.0	26.6	7.6	14.4	0.5
		ratio	NT	NT	NT	NT	NT	SD	6.2	7.2	3.7	3.2	
								ratio	NA	0.99	0.28	0.53	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.2	8.0	10.8	11.8	
		ratio	NT	NT	NT	NT	NT	SD	5.0	2.4	4.0	2.2	
								ratio	NA	0.47	0.63	0.69	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	27.0	19.0	8.8	9.0	2.1
		ratio	NT	NT	NT	NT	NT	SD	6.2	7.3	3.1	3.7	
								ratio	NA	0.70	0.33	0.33	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.2	9.8	9.6	8.2	
		ratio	NT	NT	NT	NT	NT	SD	5.0	4.6	3.7	2.3	
								ratio	NA	0.57	0.56	0.48	

Table 15. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Austin, Texas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	39.5	NT	36.0	57.5	40.5	Mean	21.6	24.6	26.0	28.4	18.3
		ratio	NA	NT	0.91	1.46	1.03	SD	6.0	2.7	3.5	3.6	
								ratio	NA	1.14	1.20	1.31	
	-	Mean	21.0	13.5	17.0	24.5	13.0	Mean	19.6	20.2	17.6	15.0	
		ratio	NA	0.64	0.81	1.17	0.62	SD	3.8	6.9	3.9	4.6	
								ratio	NA	1.03	0.90	0.77	
Finished water	+	Mean	39.5	97.0	45.0	50.0	51.0	Mean	21.6	24.8	30.2	30.8	8.3
		ratio	NA	2.46**	1.14	1.27	1.29	SD	6.0	9.0	5.5	3.3	
								ratio	NA	1.15	1.40	1.43	
	-	Mean	21.0	17.0	26.5	23.0	26.0	Mean	19.6	18.4	21.2	18.0	
		ratio	NA	0.81	1.26	1.10	1.24	SD	3.8	1.7	5.0	4.6	
								ratio	NA	0.94	1.08	0.92	
Dist. I	+	Mean	39.5	46.0	40.5	33.0	41.0	Mean	21.6	19.4	26.6	35.2	0.5
		ratio	NA	1.16	1.03	0.84	1.04	SD	6.0	4.4	4.0	5.3	
								ratio	NA	0.90	1.23	1.63*	
	-	Mean	21.0	11.5	17.0	35.0	24.0	Mean	19.6	19.0	18.0	17.4	
		ratio	NA	0.55	0.81	1.67*	1.14	SD	3.8	1.6	5.0	4.6	
								ratio	NA	0.97	0.92	0.89	
Dist. II	+	Mean	39.5	30.0	27.0	37.0	48.0	Mean	21.6	24.6	31.4	35.2	2.1
		ratio	NA	0.76	0.68	0.94	1.21	SD	6.0	5.7	7.5	8.8	
								ratio	NA	1.14	1.45	1.63*	
	-	Mean	21.0	21.0	15.5	20.0	22.0	Mean	19.6	17.0	21.4	15.6	
		ratio	NA	1.00	0.72	0.95	1.05	SD	3.8	3.1	3.1	5.4	
								ratio	NA	0.87	1.09	0.80	

Table 16. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Billings, Montana. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	66.5	66.5	79.0	67.0	49.5	Mean	61.4	38.0	67.6	43.4	0.1
		SD						SD	8.93	NC	26.62	4.67	
		ratio	NA	1.0	1.19	1.01	0.74	ratio	NA	0.62	1.10	0.71	
	-	Mean	58.5	73.0	49.0	47.0	42.0	Mean	46.0	45.0	68.4	66.2	
		SD						SD	11.16	3.0	15.37	26.26	
		ratio	NA	1.25	0.84	0.80	0.72	ratio	NA	0.98	1.49	1.44	
Finished water	+	Mean	66.5	55.0	44.5	47.0	49.0	Mean	61.4	43.4	63.4	58.8	ND
		SD						SD	8.93	13.50	11.59	14.11	
		ratio	NA	0.83	0.67	0.71	0.73	ratio	NA	0.71	1.03	0.96	
	-	Mean	58.5	49.5	36.0	41.0	40.0	Mean	46.0	49.4	52.2	58.4	
		SD						SD	11.16	22.91	9.26	7.96	
		ratio	NA	0.85	0.62	0.70	0.68	ratio	NA	1.07	1.13	1.27	
Dist. I	+	Mean	66.5	51.5	70.0	61.5	67.0	Mean	61.4	60.6	62.0	71.6	ND
		SD						SD	8.93	11.01	8.34	6.23	
		ratio	NA	0.77	1.05	0.92	1.00	ratio	NA	0.99	1.01	1.17	
	-	Mean	58.5	58.0	40.0	59.5	51.5	Mean	46.0	71.0	66.6	67.6	
		SD						SD	11.16	9.87	4.28	9.61	
		ratio	NA	0.99	0.68	1.02	0.88	ratio	NA	1.54*	1.45	1.47	
Dist. II	+	Mean	66.5	45.5	57.5	47.0	62.0	Mean	61.4	96.4	64.0	67.4	ND
		SD						SD	8.93	30.53	7.62	8.96	
		ratio	NA	0.68	0.86	0.71	0.93	ratio	NA	1.57*	1.04	1.10	
	-	Mean	58.5	53.0	56.5	40.0	44.0	Mean	46.0	42.8	58.2	57.2	
		SD						SD	11.16	9.04	6.57	9.73	
		ratio	NA	0.91	0.97	0.68	0.72	ratio	NA	0.93	1.27	1.24	

Table 17. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Billings, Montana. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	107.0	112.0	102.5	101.0	109.5	Mean	261.4	154.6	200.8	213.8	0.1
		SD						SD	15.96	29.95	12.57	20.38	
		ratio	NA	1.02	0.96	0.94	1.02	ratio	NA	0.59	0.77	0.81	
	-	Mean	92.5	107.0	98.0	72.0	94.5	Mean	241.2	117.0	153.4	178.8	
		SD						SD	35.79	22.44	13.67	13.10	
		ratio	NA	1.16	1.06	0.77	1.02	ratio	NA	0.48	0.64	0.74	
Finished water	+	Mean	107.0	84.5	98.5	101.5	93.0	Mean	261.4	170.4	249.2	232.8	ND
		SD						SD	15.96	34.76	14.39	19.07	
		ratio	NA	0.79	0.92	0.95	0.87	ratio	NA	0.65	0.95	0.89	
	-	Mean	92.5	94.5	102.0	89.5	82.0	Mean	241.2	145.2	207.0	217.0	
		SD						SD	35.79	13.66	22.88	27.30	
		ratio	NA	1.02	1.10	0.97	0.89	ratio	NA	0.60	1.61*	0.90	
Dist. I	+	Mean	107.0	84.5	79.0	88.0	85.5	Mean	261.4	202.4	260.0	243.6	ND
		SD						SD	15.96	29.23	23.71	9.74	
		ratio	NA	0.79	0.74	0.82	0.80	ratio	NA	0.77	0.99	0.93	
	-	Mean	92.5	77.0	125.5	130.5	94.5	Mean	241.2	249.2	275.4	248.6	
		SD						SD	35.79	18.73	43.07	14.33	
		ratio	NA	0.83	1.36	1.41	1.02	ratio	NA	1.03	1.14	1.03	
Dist. II	+	Mean	107.0	104.5	82.0	123.0	34.5	Mean	261.4	221.6	253.6	243.2	ND
		SD						SD	15.96	13.56	24.98	27.81	
		ratio	NA	0.98	0.77	1.15	0.32	ratio	NA	0.84	0.97	0.93	
	-	Mean	92.5	142.0	134.0	104.0	24.0	Mean	241.2	193.2	263.4	254.4	
		SD						SD	35.79	8.70	9.99	31.06	
		ratio	NA	1.54*	1.45	1.12	0.26	ratio	NA	0.80	1.09	1.05	

Table 18. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Billings, Montana. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	75.0	58.0	64.5	113.5	112.5	Mean	57.2	64.4	53.6	55.4	0.1
		SD						SD	20.17	9.02	6.62	13.01	
		ratio	NA	0.77	0.85	1.51*	1.50*	ratio	NA	1.13	0.93	1.03	
	-	Mean	69.0	86.5	73.0	77.5	66.0	Mean	72.0	122.2	82.8	73.8	
		SD						SD	16.58	18.97	2.68	7.73	
		ratio	NA	1.25	1.06	1.12	0.96	ratio	NA	1.70*	1.15	1.03	
Finished water	+	Mean	75.0	57.0	76.0	76.0	60.0	Mean	57.2	49.6	49.6	54.8	ND
		SD						SD	20.17	8.23	5.46	10.89	
		ratio	NA	0.76	1.01	1.01	0.80	ratio	NA	0.87	0.87	0.96	
	-	Mean	69.0	46.0	55.0	44.0	58.0	Mean	72.0	97.6	79.2	98.4	
		SD						SD	16.58	20.50	8.17	13.56	
		ratio	NA	0.67	0.80	0.63	0.84	ratio	NA	1.36	1.10	1.37	
Dist. I	+	Mean	75.0	52.5	51.0	54.5	50.5	Mean	57.2	56.8	54.0	75.8	ND
		SD						SD	20.17	9.98	8.63	6.53	
		ratio	NA	0.70	0.68	0.73	0.67	ratio	NA	0.99	0.94	1.33	
	-	Mean	69.0	54.0	71.0	60.5	68.0	Mean	72.0	124.0	75.4	93.8	
		SD						SD	16.58	17.0	13.81	6.61	
		ratio	NA	0.7	1.03	0.88	0.99	ratio	NA	1.72*	1.05	1.30	
Dist. II	+	Mean	75.0	46.0	42.0	52.5	52.5	Mean	57.2	63.4	45.6	44.2	ND
		SD						SD	20.17	7.57	5.18	3.03	
		ratio	NA	0.61	0.56	0.70	0.70	ratio	NA	1.11	0.79	0.77	
	-	Mean	69.0	42.5	52.5	48.0	48.0	Mean	72.0	93.7	64.4	77.2	
		SD						SD	16.58	22.07	15.24	13.48	
		ratio	NA	0.62	0.76	0.70	0.70	ratio	NA	1.30	0.89	1.07	

Table 19. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Billings, Montana. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	612	48.6	54.4	59.2	0.1
		SD	NT	NT	NT	NT	NT	SD	9.26	11.82	4.34	6.69	
		ratio						ratio	NA	0.79	0.89	0.97	
	-	Mean	NT	NT	NT	NT	NT	Mean	37.8	34.0	44.0	40.2	
		SD	NT	NT	NT	NT	NT	SD	4.97	6.89	6.28	9.78	
		ratio						ratio	NA	0.90	1.16	1.06	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	61.2	51.2	47.2	53.0	ND
		SD	NT	NT	NT	NT	NT	SD	9.26	10.35	4.34	5.74	
		ratio						ratio	NA	0.84	0.77	0.87	
	-	Mean	NT	NT	NT	NT	NT	Mean	37.8	30.0	37.6	42.8	
		SD	NT	NT	NT	NT	NT	SD	4.96	8.49	18.23	11.73	
		ratio						ratio	NA	0.79	0.99	1.13	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	61.2	63.2	50.4	44.4	ND
		SD	NT	NT	NT	NT	NT	SD	9.26	20.68	13.13	14.81	
		ratio						ratio	NA	1.03	0.82	1.17	
	-	Mean	NT	NT	NT	NT	NT	Mean	37.8	29.2	39.4	66.2	
		SD	NT	NT	NT	NT	NT	SD	4.96	12.26	14.26	9.60	
		ratio						ratio	NA	0.77	1.04	1.08	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	61.2	37.2	44.2	54.2	ND
		SD	NT	NT	NT	NT	NT	SD	9.26	13.22	9.18	7.22	
		ratio						ratio	NA	0.61	0.72	0.89	
	-	Mean	NT	NT	NT	NT	NT	Mean	37.8	13.8	30.6	39.4	
		SD	NT	NT	NT	NT	NT	SD	4.96	10.35	5.77	6.58	
		ratio						ratio	NA	0.36	0.81	1.04	

Table 20. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Billings, Montana. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	32.0	41.0	55.0	35.0	25.0	Mean	27.0	25.6	29.2	28.8	0.1
		SD						SD	6.52	4.51	9.60	5.45	
		ratio	NA	1.28	1.73*	1.09	0.78	ratio	NA	0.95	1.08	1.07	
	-	Mean	36.0	32.0	63.0	29.0	35.0	Mean	20.0	22.2	32.8	29.2	
		SD						SD	2.55	2.68	5.89	1.79	
		ratio	NA	0.89	1.75*	0.81	0.97	ratio	NA	1.11	1.64**	1.46	
Finished water	+	Mean	32.0	26.5	23.5	23.0	23.5	Mean	27.0	25.4	27.0	27.6	ND
		SD						SD	6.52	12.30	6.0	1.14	
		ratio	NA	0.83	0.73	0.72	0.73	ratio	NA	0.94	1.00	1.02	
	-	Mean	36.0	31.0	31.5	24.5	25.5	Mean	20.0	21.2	28.8	27.6	
		SD						SD	2.55	6.65	5.07	2.88	
		ratio	NA	0.86	0.88	0.68	0.71	ratio	NA	1.06	1.44	1.38	
Dist. I	+	Mean	32.0	28.5	29.0	28.5	30.0	Mean	27.0	20.0	17.0	20.8	ND
		SD						SD	6.52	4.58	2.92	4.09	
		ratio	NA	0.89	0.91	0.89	0.94	ratio	NA	0.74	0.62	0.77	
	-	Mean	36.0	23.5	27.5	25.5	19.0	Mean	20.0	20.0	16.2	15.4	
		SD						SD	2.55	3.81	6.76	1.34	
		ratio	NA	0.65	0.76	0.71	0.53	ratio	NA	1.00	0.66	0.77	
Dist. II	+	Mean	32.0	23.0	35.0	58.0	96.0	Mean	27.0	24.8	20.2	19.8	ND
		SD						SD	6.52	14.17	3.76	2.77	
		ratio	NA	0.72	1.09	1.81*	3.0**	ratio	NA	0.91	0.74	0.73	
	-	Mean	36.0	22.0	18.0	32.0	106.5	Mean	20.0	15.8	17.2	16.0	
		SD						SD	2.55	10.01	7.09	1.58	
		ratio	NA	0.61	0.50	0.89	2.96**	ratio	NA	0.79	0.80	0.80	

Table 21. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Champaign, Illinois (I-1). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	HS	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	91.0	NT	NT	NT	102.0	Mean	58.6	83.6	86.0	70.8	6.9
		ratio	NA	NT	NT	NT	1.12	SD	14.8	7.5	11.5	1.6	
								ratio	NA	1.42	1.47	1.21	
	-	Mean	71.5	NT	NT	NT	50.0	Mean	28.2	40.6	59.8	46.0	
		ratio	NA	NT	NT	NT	0.70	SD	4.2	3.4	19.3	4.1	
								ratio	NA	1.44	2.12**	1.63*	
Finished water	+	Mean	91.0	NT	NT	NT	80.0	Mean	58.6	84.6	81.6	77.6	2.8
		ratio	NA	NT	NT	NT	0.88	SD	14.8	11.5	7.2	8.9	
								ratio	NA	1.44	1.39	1.32	
	-	Mean	71.5	NT	NT	NT	36.0	Mean	28.2	36.0	53.0	48.4	
		ratio	NA	NT	NT	NT	0.50	SD	4.2	5.0	3.4	7.6	
								ratio	NA	1.28	1.88*	1.72*	
Dist. I	+	Mean	91.0	NT	NT	NT	>500.0	Mean	58.6	87.2	73.6	91.2	NT
		ratio	NA	NT	NT	NT	>5.49**	SD	14.8	14.3	9.0	14.6	
								ratio	NA	1.49	1.26	1.56*	
	-	Mean	71.5	NT	NT	NT	42.0	Mean	28.2	42.4	46.4	55.8	
		ratio	NA	NT	NT	NT	0.58	SD	4.2	4.8	6.7	5.4	
								ratio	NA	1.50*	1.65*	1.98*	
Dist. II	+	Mean	91.0	NT	NT	NT	>500.0	Mean	58.6	93.2	87.4	76.8	6.2
		ratio	NA	NT	NT	NT	>5.49**	SD	14.8	15.7	10.4	14.0	
								ratio	NA	1.59*	1.49	1.31	
	-	Mean	71.5	NT	NT	NT	43.5	Mean	28.2	40.2	43.8	39.6	
		ratio	NA	NT	NT	NT	0.61	SD	4.2	8.4	12.7	6.4	
								ratio	NA	1.43	1.55*	1.40	

Table 22. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Champaign, Illinois (I-2). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	HS	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	86.0	NT	NT	NT	95.0	Mean	NT	NT	NT	NT	6.9
		ratio	NA	NT	NT	NT	1.10	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
	-	Mean	56.0	NT	NT	NT	39.5	Mean	NT	NT	NT	NT	
		ratio	NA	NT	NT	NT	0.71	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
Finished water	+	Mean	86.0	NT	NT	NT	99.5	Mean	NT	NT	NT	NT	2.8
		ratio	NA	NT	NT	NT	1.16	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
	-	Mean	56.0	NT	NT	NT	54.5	Mean	NT	NT	NT	NT	
		ratio	NA	NT	NT	NT	0.97	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
Dist. I	+	Mean	86.0	NT	NT	NT	95.0	Mean	NT	NT	NT	NT	NT
		ratio	NA	NT	NT	NT	1.10	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
	-	Mean	56.0	NT	NT	NT	52.0	Mean	NT	NT	NT	NT	
		ratio	NA	NT	NT	NT	0.93	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
Dist. II	+	Mean	86.0	NT	NT	NT	82.0	Mean	NT	NT	NT	NT	6.2
		ratio	NA	NT	NT	NT	0.95	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
	-	Mean	56.0	NT	NT	NT	57.5	Mean	NT	NT	NT	NT	
		ratio	NA	NT	NT	NT	1.03	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	

Table 23. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Champaign, Illinois (I). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	164.6	152.2	210.2	204.8	6.9
		SD	NT	NT	NT	NT	NT	SD	12.7	20.0	11.9	19.3	
		ratio						ratio	NA	0.93	1.28	1.24	
	-	Mean	NT	NT	NT	NT	NT	Mean	204.4	236.2	315.2	345.4	
		SD	NT	NT	NT	NT	NT	SD	10.4	14.7	22.0	40.0	
		ratio						ratio	NA	1.16	1.54*	1.69*	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	164.6	144.0	192.6	203.4	2.8
		SD	NT	NT	NT	NT	NT	SD	12.7	16.9	33.2	23.8	
		ratio						ratio	NA	0.88	1.17	1.24	
	-	Mean	NT	NT	NT	NT	NT	Mean	204.4	178.6	266.4	294.2	
		SD	NT	NT	NT	NT	NT	SD	10.4	45.0	25.5	37.9	
		ratio						ratio	NA	0.87	1.30	1.44	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	164.6	139.0	238.2	321.8	NT
		SD	NT	NT	NT	NT	NT	SD	12.7	21.8	34.2	36.8	
		ratio						ratio	NA	0.85	1.45	2.00**	
	-	Mean	NT	NT	NT	NT	NT	Mean	204.4	204.6	380.6	340.6	
		SD	NT	NT	NT	NT	NT	SD	10.4	17.2	18.5	29.0	
		ratio						ratio	NA	1.00	1.86*	1.67*	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	164.6	163.0	268.0	195.6	6.2
		SD	NT	NT	NT	NT	NT	SD	12.7	19.9	27.1	44.8	
		ratio						ratio	NA	0.99	1.63*	1.19	
	-	Mean	NT	NT	NT	NT	NT	Mean	204.4	227.6	305.2	327.8	
		SD	NT	NT	NT	NT	NT	SD	10.4	13.5	38.9	11.3	
		ratio						ratio	NA	1.11	1.49	1.60	

Table 24. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Champaign, Illinois (I). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	40.5	NT	NT	NT	31.0	Mean	43.2	99.4	45.2	143.6	6.9
		SD	NA	NT	NT	NT	0.77	SD	7.6	11.4	2.5	10.6	
		ratio						ratio	NA	2.30**	1.05	3.32*	
	-	Mean	121.0	NT	NT	NT	85.5	Mean	82.0	59.0	146.4	37.6	
		SD	NA	NT	NT	NT	0.71	SD	9.4	4.6	18.3	5.2	
		ratio						ratio	NA	0.72	1.79*	0.46	
Finished water	+	Mean	40.5	NT	NT	NT	106.0	Mean	43.2	37.0	55.8	144.6	2.8
		SD	NA	NT	NT	NT	2.62**	SD	7.6	5.6	8.5	14.4	
		ratio						ratio	NA	0.86	1.29	3.35**	
	-	Mean	121.0	NT	NT	NT	45.5	Mean	82.0	20.6	139.2	56.0	
		SD	NA	NT	NT	NT	0.38	SD	9.4	4.2	21.1	9.3	
		ratio						ratio	NA	0.25	1.70*	0.68	
Dist. I	+	Mean	40.5	NT	NT	NT	30.5	Mean	43.2	56.4	53.8	103.6	NT
		SD	NA	NT	NT	NT	0.75	SD	7.6	2.3	8.1	18.3	
		ratio						ratio	NA	1.31	1.25	2.40**	
	-	Mean	121.0	NT	NT	NT	100.5	Mean	82.0	116.8	93.6	45.2	
		SD	NA	NT	NT	NT	0.83	SD	9.4	17.5	29.4	7.2	
		ratio						ratio	NA	1.42	1.14	0.55	
Dist. II	+	Mean	40.5	NT	NT	NT	35.0	Mean	43.2	92.4	131.6	53.8	6.2
		SD	NA	NT	NT	NT	0.86	SD	7.6	12.0	32.7	12.4	
		ratio						ratio	NA	2.14**	3.05**	1.25	
	-	Mean	121.0	NT	NT	NT	103.5	Mean	82.0	99.6	55.6	101.2	
		SD	NA	NT	NT	NT	0.86	SD	9.4	3.8	11.3	30.0	
		ratio						ratio	NA	1.22	0.68	1.23	

Table 25. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Champaign, Illinois (I). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay, Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay, Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	40.0	37.0	26.2	34.8	6.9
		ratio	NT	NT	NT	NT	NT	SD	5.2	5.6	2.8	5.3	
								ratio	NA	0.93	0.66	0.87	
	-	Mean	NT	NT	NT	NT	NT	Mean	19.8	19.0	31.6	30.2	
		ratio	NT	NT	NT	NT	NT	SD	3.3	6.0	5.3	5.5	
								ratio	NA	0.96	1.60*	1.53*	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	90.0	48.4	44.2	43.4	2.8
		ratio	NT	NT	NT	NT	NT	SD	5.2	5.3	7.2	6.6	
								ratio	NA	1.21	1.11	1.09	
	-	Mean	NT	NT	NT	NT	NT	Mean	19.8	14.6	28.2	26.0	
		ratio	NT	NT	NT	NT	NT	SD	3.3	3.4	4.6	4.9	
								ratio	NA	0.74	1.42	1.31	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	40.0	39.6	23.4	23.0	NT
		ratio	NT	NT	NT	NT	NT	SD	5.2	9.8	1.7	7.4	
								ratio	NA	0.99	0.59	0.58	
	-	Mean	NT	NT	NT	NT	NT	Mean	19.8	17.4	41.8	35.2	
		ratio	NT	NT	NT	NT	NT	SD	3.3	3.0	9.4	7.1	
								ratio	NA	0.88	2.11**	1.78*	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	40.0	41.0	22.8	24.2	6.2
		ratio	NT	NT	NT	NT	NT	SD	5.2	5.7	4.3	7.8	
								ratio	NA	1.03	0.57	0.61	
	-	Mean	NT	NT	NT	NT	NT	Mean	19.8	17.8	38.8	35.4	
		ratio	NT	NT	NT	NT	NT	SD	3.3	4.2	5.9	4.7	
								ratio	NA	0.90	1.96*	1.79*	

Table 26. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Champaign, Illinois (I). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	HS	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	97.5	NT	NT	NT	95.5	Mean	64.2	84.4	67.4	69.8	6.9
		ratio	NA	NT	NT	NT	0.98	SD	7.7	7.8	4.2	5.2	
								ratio	NA	1.32	1.05	1.09	
	-	Mean	45.5	NT	NT	NT	43.5	Mean	50.6	52.6	58.4	60.8	
		ratio	NA	NT	NT	NT	0.96	SD	2.3	3.1	6.3	6.0	
								ratio	NA	1.04	1.15	1.20	
Finished water	+	Mean	97.5	NT	NT	NT	93.0	Mean	64.2	90.4	76.4	71.2	2.8
		ratio	NA	NT	NT	NT	0.95	SD	7.7	16.7	11.5	10.0	
								ratio	NA	1.41	1.19	1.11	
	-	Mean	45.5	NT	NT	NT	38.5	Mean	50.6	60.2	60.6	59.4	
		ratio	NA	NT	NT	NT	0.85	SD	2.3	4.6	8.9	8.2	
								ratio	NA	1.19	1.20	1.17	
Dist. I	+	Mean	97.5	NT	NT	NT	92.0	Mean	64.2	93.8	64.4	74.8	NT
		ratio	NA	NT	NT	NT	0.94	SD	7.7	14.8	6.7	9.6	
								ratio	NA	1.46	1.00	1.17	
	-	Mean	45.5	NT	NT	NT	40.5	Mean	50.6	50.6	53.6	56.6	
		ratio	NA	NT	NT	NT	0.89	SD	2.3	10.5	4.0	8.8	
								ratio	NA	1.00	1.06	1.12	
Dist. II	+	Mean	97.5	NT	NT	NT	94.5	Mean	64.2	104.0	72.4	82.2	6.2
		ratio	NA	NT	NT	NT	0.97	SD	7.7	7.9	6.1	11.6	
								ratio	NA	1.62*	1.13	1.28	
	-	Mean	45.5	NT	NT	NT	34.5	Mean	50.6	58.2	56.2	58.6	
		ratio	NA	NT	NT	NT	0.76	SD	2.3	14.0	5.3	7.9	
								ratio	NA	1.15	1.11	1.16	

Table 27. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Champaign, Illinois (II). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	89.5	112.5	109.0	87.0	107.5	Mean	75.4	62.4	107.8	89.6	ND
		SD						SD	8.2	6.7	32.3	16.0	
		ratio	NA	1.26	1.22	0.97	1.20	ratio	NA	0.83	1.40	1.19	
	-	Mean	115.5	60.0	61.5	47.5	40.0	Mean	92.2	81.6	66.0	59.2	
		SD						SD	19.7	7.1	17.1	13.4	
		ratio	NA	0.52	0.53	0.41	0.35	ratio	NA	0.89	0.72	0.64	
Finished water	+	Mean	89.5	126.0	101.5	116.0	123.5	Mean	75.4	138.0	126.0	145.0	0.1
		SD						SD	8.2	35.6	14.2	34.1	
		ratio	NA	1.41	1.13	1.30	1.38	ratio	NA	1.83*	1.67*	1.93*	
	-	Mean	115.5	133.0	113.0	283.5	173.0	Mean	92.2	85.0	59.0	55.8	
		SD						SD	19.7	11.5	8.0	9.4	
		ratio	NA	1.15	0.98	2.46**	1.50*	ratio	NA	0.92	0.65	0.61	
Dist. I	+	Mean	89.5	103.0	109.0	108.5	98.0	Mean	75.4	88.8	120.0	152.2	64.7
		SD						SD	8.2	13.0	22.7	37.0	
		ratio	NA	1.15	1.22	1.21	1.10	ratio	NA	1.18	1.59*	2.02**	
	-	Mean	115.5	100.0	198.0	116.5	152.0	Mean	92.2	83.0	67.0	66.0	
		SD						SD	19.7	11.3	17.5	8.2	
		ratio	NA	0.87	1.71*	1.01	1.32	ratio	NA	0.90	0.73	0.72	
Dist. II	+	Mean	89.5	138.0	198.0	79.0	113.5	Mean	75.4	142.4	153.8	130.4	0.2
		SD						SD	8.2	37.1	16.5	13.7	
		ratio	NA	1.54*	2.21**	0.88	1.27	ratio	NA	1.89*	2.04**	1.73*	
	-	Mean	115.5	98.5	89.5	142.5	118.0	Mean	92.2	90.4	66.0	67.0	
		SD						SD	19.7	6.4	11.3	8.2	
		ratio	NA	0.15	0.78	1.23	1.02	ratio	NA	0.98	0.72	0.73	

Table 28. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Champaign, Illinois (II). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	269.5	180.5	184.5	215.5	200.5	Mean	197.0	211.6	168.6	189.6	ND
		SD						SD	7.1	61.3	10.0	28.4	
		ratio	NA	0.67	0.69	0.80	0.74	ratio	NA	1.07	0.86	0.96	
	-	Mean	289.0	323.0	476.5	517.0	465.0	Mean	220.0	209.0	221.2	244.4	
		SD						SD	19.8	60.2	47.1	22.7	
		ratio	NA	1.12	1.65*	1.79*	1.61*	ratio	NA	0.95	1.01	1.11	
Finished water	+	Mean	269.5	235.0	189.0	200.0	184.0	Mean	197.0	172.6	170.0	185.2	0.1
		SD						SD	7.1	11.8	26.1	33.1	
		ratio	NA	0.87	0.70	0.74	0.68	ratio	NA	0.88	0.86	0.94	
	-	Mean	289.0	335.5	548.0	561.0	512.5	Mean	220.0	183.6	184.2	213.2	
		SD						SD	19.8	22.5	13.0	19.6	
		ratio	NA	1.16	1.90*	1.94*	1.77*	ratio	NA	0.84	0.84	0.97	
Dist. I	+	Mean	269.5	224.5	208.5	156.5	183.5	Mean	197.0	187.8	163.4	184.8	64.7
		SD						SD	7.1	8.8	16.4	49.5	
		ratio	NA	0.83	0.77	0.58	0.68	ratio	NA	0.95	0.83	0.94	
	-	Mean	289.0	450.0	503.5	322.5	447.0	Mean	220.0	198.6	197.6	203.4	
		SD						SD	19.8	22.5	27.8	27.8	
		ratio	NA	1.56*	1.74*	1.12	1.55*	ratio	NA	0.90	0.90	0.93	
Dist. II	+	Mean	269.5	218.0	268.0	178.5	221.5	Mean	197.0	225.6	158.0	161.0	0.2
		SD						SD	7.1	40.2	28.0	24.4	
		ratio	NA	0.81	0.99	0.66	0.82	ratio	NA	1.15	0.80	0.73	
	-	Mean	289.0	246.5	216.0	571.0	511.5	Mean	220.0	234.2	192.4	207.0	
		SD						SD	19.8	40.6	18.8	33.7	
		ratio	NA	0.85	0.75	1.98*	1.77*	ratio	NA	1.07	0.88	0.94	

Table 29. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Champaign, Illinois (II). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	56.5	66.5	67.0	75.5	61.5	Mean	59.0	70.4	84.0	86.6	ND
		SD						SD	9.3	5.3	8.0	7.7	
		ratio	NA	1.18	1.19	1.34	1.09	ratio	NA	1.19	1.43	1.47	
	-	Mean	212.0	138.5	144.0	173.0	174.0	Mean	106.8	57.0	60.0	55.2	
		SD						SD	19.3	36.2	11.5	22.0	
		ratio	NA	0.65	1.68	0.82	0.82	ratio	NA	0.53	0.56	0.52	
Finished water	+	Mean	56.5	50.5	55.0	40.0	30.0	Mean	59.0	82.4	82.6	83.6	0.1
		SD						SD	9.3	9.2	12.0	8.9	
		ratio	NA	0.89	0.97	0.71	0.53	ratio	NA	1.40	1.40	1.42	
	-	Mean	212.0	140.5	129.5	64.5	122.5	Mean	106.8	82.8	95.4	105.4	
		SD						SD	19.3	30.0	6.8	14.7	
		ratio	NA	0.66	0.61	0.30	0.58	ratio	NA	0.78	0.89	0.99	
Dist. I	+	Mean	56.5	50.0	26.5	45.5	38.0	Mean	59.0	70.4	100.6	93.0	64.7
		SD						SD	9.3	13.1	26.6	18.6	
		ratio	NA	0.88	0.47	0.81	0.67	ratio	NA	1.19	1.71*	1.58*	
	-	Mean	212.0	162.5	138.5	115.0	148.0	Mean	106.8	173.8	86.4	96.2	
		SD						SD	19.3	30.5	7.13	8.9	
		ratio	NA	0.77	0.65	0.54	0.70	ratio	NA	1.63*	0.81	0.90	
Dist. II	+	Mean	56.5	40.5	45.0	40.5	32.0	Mean	59.0	82.6	74.6	94.8	0.2
		SD						SD	9.3	13.2	8.1	6.7	
		ratio	NA	0.72	0.80	0.72	0.57	ratio	NA	1.40	1.26	1.61*	
	-	Mean	212.0	65.5	64.0	214.0	285.0	Mean	106.8	71.6	87.4	81.4	
		SD						SD	19.3	18.3	8.0	9.6	
		ratio	NA	0.31	0.30	1.01	1.34	ratio	NA	0.67	0.82	0.76	

Table 30. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Champaign, Illinois (II). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	34.4	57.4	56.4	60.2	ND
		SD	NT	NT	NT	NT	NT	SD	4.2	9.7	13.2	14.0	
		ratio						ratio	NA	1.67*	1.64*	1.75*	
	-	Mean	NT	NT	NT	NT	NT	Mean	43.6	49.6	48.2	58.0	
		SD	NT	NT	NT	NT	NT	SD	7.3	2.4	11.4	5.5	
		ratio						ratio	NA	1.14	1.11	1.33	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	34.4	62.2	39.8	50.8	0.1
		SD	NT	NT	NT	NT	NT	SD	4.2	11.1	7.3	15.5	
		ratio						ratio	NA	1.81*	1.16	1.48	
	-	Mean	NT	NT	NT	NT	NT	Mean	43.6	57.8	23.8	49.2	
		SD	NT	NT	NT	NT	NT	SD	7.3	11.9	6.1	10.2	
		ratio						ratio	NA	1.33	0.55	1.13	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	34.4	60.4	75.6	69.0	64.7
		SD	NT	NT	NT	NT	NT	SD	4.2	9.5	14.5	17.6	
		ratio						ratio	NA	1.76*	2.20**	2.01**	
	-	Mean	NT	NT	NT	NT	NT	Mean	43.6	75.8	75.8	58.0	
		SD	NT	NT	NT	NT	NT	SD	7.3	15.2	9.0	12.2	
		ratio						ratio	NA	1.74*	1.74*	1.33	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	34.4	66.6	53.4	71.0	0.2
		SD	NT	NT	NT	NT	NT	SD	4.2	7.8	15.6	18.2	
		ratio						ratio	NA	1.94*	1.55*	2.10**	
	-	Mean	NT	NT	NT	NT	NT	Mean	43.6	69.2	56.8	68.2	
		SD	NT	NT	NT	NT	NT	SD	7.3	8.5	5.8	14.2	
		ratio						ratio	NA	1.59*	1.30	1.56*	

Table 31. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Champaign, Illinois (II). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	242.0	175.5	202.0	335.5	255.5	Mean	19.0	20.0	39.0	32.0	ND
		SD						SD	4.7	4.8	6.5	11.8	
		ratio	NA	0.73	0.84	1.39	1.05	ratio	NA	1.05	2.05**	1.68*	
	-	Mean	166.0	150.5	134.0	75.5	93.0	Mean	18.4	19.4	25.4	31.0	
		SD						SD	5.2	6.8	3.5	8.0	
		ratio	NA	0.91	0.81	0.46	0.56	ratio	NA	1.05	1.38	1.69*	
Finished water	+	Mean	242.0	39.5	32.5	31.5	43.5	Mean	19.0	22.2	23.6	13.8	0.1
		SD						SD	4.7	9.2	3.3	0.84	
		ratio	NA	0.16	0.13	0.13	0.18	ratio	NA	1.17	1.24	0.73	
	-	Mean	166.0	34.5	67.5	48.5	51.0	Mean	18.4	23.6	17.2	20.2	
		SD						SD	5.2	7.0	1.6	5.0	
		ratio	NA	0.21	0.41	0.29	0.31	ratio	NA	1.28	0.93	1.10	
Dist. I	+	Mean	242.0	76.0	42.0	36.0	47.5	Mean	19.0	13.4	29.6	27.0	64.7
		SD						SD	4.7	4.3	5.2	6.0	
		ratio	NA	0.31	0.17	0.15	0.20	ratio	NA	0.71	1.56*	1.42	
	-	Mean	166.0	41.0	44.5	36.5	53.5	Mean	18.4	27.8	26.0	24.6	
		SD						SD	5.2	9.6	7.0	7.5	
		ratio	NA	0.25	0.27	0.22	0.32	ratio	NA	1.51*	1.41	1.34	
Dist. II	+	Mean	242.0	44.0	36.5	57.5	55.5	Mean	19.0	14.6	25.2	26.2	0.2
		SD						SD	4.7	2.4	10.6	5.8	
		ratio	NA	0.18	0.15	0.24	0.23	ratio	NA	0.77	1.33	1.38	
	-	Mean	166.0	46.5	44.0	51.5	61.5	Mean	18.4	23.8	23.0	32.4	
		SD						SD	5.2	3.4	4.2	4.8	
		ratio	NA	0.28	0.27	0.31	0.37	ratio	NA	1.29	1.25	1.76*	

Table 32. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Elkhart, Indiana. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	113.5	52.0	80.5	70.0	53.0	Mean	127.6	116.0	104.6	133.2	1.0
		SD						SD	13.0	13.4	23.0	32.3	
		ratio	NA	0.46	0.71	0.62	0.47	ratio	NA	0.91	0.82	1.04	
	-	Mean	130.5	118.0	78.5	108.5	63.5	Mean	94.8	83.0	90.8	135.2	
		SD						SD	15.6	27.5	28.0	41.4	
		ratio	NA	0.90	0.60	0.96	0.49	ratio	NA	0.88	0.96	1.43	
Finished water	+	Mean	113.5	112.5	214.5	132.0	97.5	Mean	127.6	135.6	63.4	104.8	0.4
		SD						SD	13.0	9.3	10.7	20.2	
		ratio	NA	0.99	1.89*	1.16	0.86	ratio	NA	1.06	0.50	0.82	
	-	Mean	130.5	259.5	154.0	168.5	99.0	Mean	94.8	113.4	89.8	101.6	
		SD						SD	15.6	13.4	16.5	7.92	
		ratio	NA	1.99*	1.18	1.29	0.76	ratio	NA	1.20	0.95	1.07	
Dist. I	+	Mean	113.5	154.5	178.5	86.0	129.0	Mean	127.6	110.8	83.6	114.8	0.3
		SD						SD	13.0	13.7	15.6	5.4	
		ratio	NA	1.36	1.57*	0.76	1.14	ratio	NA	0.87	0.66	0.90	
	-	Mean	130.5	155.0	173.5	103.0	171.0	Mean	94.8	111.0	87.8	122.2	
		SD						SD	15.6	16.0	13.0	21.3	
		ratio	NA	1.19	1.32	0.79	1.31	ratio	NA	1.17	0.93	1.30	
Dist. II	+	Mean	113.5	64.0	84.5	86.0	69.0	Mean	127.6	77.4	79.0	110.8	61.6
		SD						SD	13.0	39.8	24.9	14.4	
		ratio	NA	0.56	0.74	0.76	0.61	ratio	NA	0.61	0.62	0.87	
	-	Mean	130.5	90.5	88.0	89.0	97.5	Mean	94.8	49.0	115.2	122.6	
		SD						SD	15.6	14.9	18.4	20.7	
		ratio	NA	0.96	0.67	0.68	0.75	ratio	NA	0.52	1.22	1.29	

Table 33. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Elkhart, Indiana. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	343.0	288.5	303.0	229.0	207.0	Mean	268.6	379.4	255.2	332.6	1.0
		SD						SD	34.1	39.6	52.3	77.3	
		ratio	NA	0.84	0.88	0.67	0.60	ratio	NA	1.41	0.95	1.24	
	-	Mean	220.0	228.5	193.5	286.5	270.5	Mean	311.6	287.0	272.0	323.4	
		SD						SD	12.8	25.4	38.1	36.7	
		ratio	NA	1.04	0.88	1.30	1.23	ratio	NA	0.92	0.87	1.04	
Finished water	+	Mean	343.0	297.5	311.0	337.0	270.0	Mean	268.6	372.2	241.8	228.0	0.4
		SD						SD	34.1	30.4	15.1	33.4	
		ratio	NA	0.87	0.91	0.98	0.79	ratio	NA	1.39	0.90	0.85	
	-	Mean	220.0	213.5	235.5	216.5	239.0	Mean	311.6	358.6	286.0	242.4	
		SD						SD	12.8	21.1	36.0	20.9	
		ratio	NA	0.97	1.07	0.98	1.09	ratio	NA	1.15	0.92	0.78	
Dist. I	+	Mean	343.0	326.0	292.0	292.5	252.5	Mean	268.6	364.0	256.8	305.0	0.3
		SD						SD	34.1	52.3	24.4	58.0	
		ratio	NA	0.95	0.85	0.85	0.74	ratio	NA	0.82	0.78	0.88	
	-	Mean	220.0	251.5	250.5	180.5	321.5	Mean	311.6	254.4	244.0	275.6	
		SD						SD	12.8	32.7	18.4	25.7	
		ratio	NA	1.14	1.14	0.82	1.46	ratio	NA	0.82	0.78	0.88	
Dist. II	+	Mean	343.0	237.5	170.5	126.5	138.5	Mean	268.6	249.4	295.6	349.6	61.6
		SD						SD	34.1	45.1	45.7	52.7	
		ratio	NA	0.69	0.50	0.58	0.40	ratio	NA	0.93	1.10	1.30	
	-	Mean	220.0	198.5	195.5	137.0	152.0	Mean	311.6	175.0	268.4	287.0	
		SD						SD	12.8	71.0	44.1	35.0	
		ratio	NA	0.90	0.89	0.62	0.69	ratio	NA	0.56	0.86	0.92	

Table 34. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Elkhart, Indiana. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay, Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay, Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	42.5	44.5	81.0	50.5	57.0	Mean	89.6	68.0	94.4	135.4	1.0
		SD						SD	10.3	4.6	5.2	14.6	
		ratio	NA	1.05	1.91*	1.19	1.35	ratio	NA	0.75	1.05	1.51*	
	-	Mean	82.0	94.5	95.0	107.5	90.0	Mean	67.2	82.6	97.4	90.8	
		SD						SD	14.4	14.9	29.0	35.1	
		ratio	NA	1.15	1.16	1.31	1.10	ratio	NA	1.2	1.45	1.35	
Finished water	+	Mean	42.5	50.5	52.0	71.0	32.0	Mean	89.6	74.8	58.8	84.4	0.4
		SD						SD	10.3	5.0	18.9	13.6	
		ratio	NA	1.19	1.22	1.67*	0.75	ratio	NA	0.83	0.66	0.94	
	-	Mean	82.0	69.5	67.5	97.5	104.5	Mean	67.2	157.4	48.2	44.8	
		SD						SD	14.4	16.4	9.8	9.2	
		ratio	NA	0.85	0.82	1.19	1.27	ratio	NA	2.34**	0.72	0.67	
Dist. I	+	Mean	42.5	78.0	57.5	58.5	37.5	Mean	89.6	71.6	71.6	75.0	0.3
		SD						SD	10.3	7.8	3.6	4.5	
		ratio	NA	1.84*	1.35	1.38	0.88	ratio	NA	0.80	0.80	0.84	
	-	Mean	82.0	92.0	82.0	72.5	91.5	Mean	67.2	89.0	43.0	31.4	
		SD						SD	14.4	18.5	5.1	6.3	
		ratio	NA	1.12	1.00	0.88	1.12	ratio	NA	1.32	0.60	0.47	
Dist. II	+	Mean	42.5	46.5	29.5	41.0	46.5	Mean	89.6	95.0	87.0	45.8	61.6
		SD						SD	10.3	6.5	4.6	11.1	
		ratio	NA	1.09	0.69	0.96	1.09	ratio	NA	1.06	1.29	0.51	
	-	Mean	82.0	64.5	61.5	79.5	81.5	Mean	67.2	107.6	55.8	87.0	
		SD						SD	14.4	45.6	12.0	4.6	
		ratio	NA	0.79	0.75	0.97	0.99	ratio	NA	1.60*	0.83	1.29	

Table 35. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Elkhart, Indiana. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	50.8	44.2	51.0	64.2	1.0
		ratio	NT	NT	NT	NT	NT	SD	6.1	8.9	14.8	14.8	
								ratio	NA	0.87	1.00	1.26	
	-	Mean	NT	NT	NT	NT	NT	Mean	57.4	34.6	44.4	51.2	
		ratio	NT	NT	NT	NT	NT	SD	5.0	10.6	6.8	6.6	
								ratio	NA	0.60	0.77	0.89	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	50.8	50.6	59.6	40.0	0.4
		ratio	NT	NT	NT	NT	NT	SD	6.1	15.24	16.8	5.2	
								ratio	NA	1.00	1.17	0.79	
	-	Mean	NT	NT	NT	NT	NT	Mean	57.4	35.0	44.6	50.0	
		ratio	NT	NT	NT	NT	NT	SD	5.0	11.0	7.3	15.3	
								ratio	NA	0.61	0.78	0.87	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	50.8	44.8	71.4	31.8	0.3
		ratio	NT	NT	NT	NT	NT	SD	6.1	5.9	7.02	13.9	
								ratio	NA	0.88	1.41	0.63	
	-	Mean	NT	NT	NT	NT	NT	Mean	57.4	39.2	69.2	23.8	
		ratio	NT	NT	NT	NT	NT	SD	5.0	7.0	9.8	11.9	
								ratio	NA	0.68	1.21	0.41	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	50.8	59.0	48.2	33.4	61.6
		ratio	NT	NT	NT	NT	NT	SD	6.1	3.5	11.9	7.1	
								ratio	NA	1.16	0.94	0.66	
	-	Mean	NT	NT	NT	NT	NT	Mean	57.4	39.8	58.6	59.0	
		ratio	NT	NT	NT	NT	NT	SD	5.0	13.4	12.5	12.0	
								ratio	NA	0.69	1.02	1.03	

Table 36. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Elkhart, Indiana. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	42.5	62.5	57.0	49.5	55.5	Mean	80.4	46.8	61.8	64.6	1.0
		SD						SD	2.6	8.3	7.6	18.5	
		ratio	NA	1.47	1.34	1.16	1.31	ratio	NA	0.58	0.77	0.80	
	-	Mean	44.0	55.5	52.5	55.0	37.0	Mean	67.6	52.4	60.0	51.6	
		SD						SD	10.4	2.6	13.9	6.8	
		ratio	NA	1.26	1.19	1.25	0.84	ratio	NA	0.78	0.88	0.76	
Finished water	+	Mean	42.5	38.5	32.0	47.5	35.5	Mean	80.4	71.6	74.4	40.8	0.4
		SD						SD	2.6	12.6	10.0	11.6	
		ratio	NA	0.91	0.75	1.12	0.84	ratio	NA	0.89	0.93	0.51	
	-	Mean	44.0	65.5	45.0	46.0	59.5	Mean	67.6	70.0	70.2	24.8	
		SD						SD	10.4	9.4	7.0	7.6	
		ratio	NA	1.49	1.02	1.05	1.32	ratio	NA	1.04	1.04	0.37	
Dist. I	+	Mean	42.5	54.5	45.5	49.5	54.5	Mean	80.4	73.2	77.0	65.0	0.3
		SD						SD	2.6	10.1	13.8	10.1	
		ratio	NA	1.28	1.07	1.16	1.28	ratio	NA	0.91	0.96	0.81	
	-	Mean	44.0	59.5	35.0	47.0	52.5	Mean	67.6	64.0	67.2	60.8	
		SD						SD	10.4	7.6	4.32	11.7	
		ratio	NA	1.35	0.80	1.06	1.19	ratio	NA	0.95	0.95	0.90	
Dist. II	+	Mean	42.5	56.5	34.0	56.5	49.5	Mean	80.4	45.4	78.8	64.4	61.6
		SD						SD	2.6	12.9	12.5	13.1	
		ratio	NA	1.33	0.80	1.33	1.16	ratio	NA	0.56	0.98	0.80	
	-	Mean	44.0	29.0	35.0	56.5	50.5	Mean	67.6	61.4	80.6	62.6	
		SD						SD	10.4	14.0	6.7	13.8	
		ratio	NA	0.66	0.80	1.28	1.15	ratio	NA	0.91	1.19	0.93	

Table 37. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Eau Claire, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	45.0	46.5	39.5	NT	22.5	Mean	36.8	17.8	26.4	38.4	ND
		SD				NT		SD	4.9	8.3	5.1	10.8	
		ratio	NA	1.03	0.88		0.50	ratio	NA	0.48	0.72	1.04	
	-	Mean	36.5	39.0	38.5	NT	40.0	Mean	25.0	18.2	25.4	25.2	
		SD				NT		SD	6.0	1.3	4.2	4.96	
		ratio	NA	1.07	1.05		1.10	ratio	NA	0.73	1.02	1.01	
Finished water	+	Mean	45.0	46.0	52.0	NT	38.5	Mean	36.8	28.4	35.6	33.8	3.7
		SD				NT		SD	4.9	9.8	4.9	6.8	
		ratio	NA	1.02	1.16		0.86	ratio	NA	0.77	0.97	0.92	
	-	Mean	36.5	42.0	37.0	NT	35.0	Mean	25.0	12.4	27.2	25.2	
		SD				NT		SD	6.0	2.1	4.97	5.1	
		ratio	NA	1.15	1.01		0.96	ratio	NA	0.50	1.09	1.01	
Dist. I	+	Mean	45.0	38.5	41.0	NT	46.5	Mean	36.8	31.4	27.2	34.8	4.5
		SD				NT		SD	4.9	14.3	8.3	6.9	
		ratio	NA	0.86	0.91		1.03	ratio	NA	0.85	0.74	0.95	
	-	Mean	36.5	32.5	34.5	NT	31.5	Mean	25.0	17.4	27.2	35.8	
		SD				NT		SD	6.0	3.4	6.2	9.0	
		ratio	NA	0.89	0.95		0.86	ratio	NA	0.70	1.09	1.43	
Dist. II	+	Mean	45.0	34.0	38.0	NT	45.0	Mean	36.8	15.4	22.0	26.2	6.9
		SD				NT		SD	4.9	1.8	8.0	10.2	
		ratio	NA	0.76	0.84		1.00	ratio	NA	0.42	0.60	0.71	
	-	Mean	36.5	36.5	39.0	NT	28.5	Mean	25.0	16.0	21.2	17.8	
		SD				NT		SD	6.0	2.7	5.5	4.5	
		ratio	NA	1.01	1.07		0.78	ratio	NA	0.64	0.85	0.71	

Table 38. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Eau Claire, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	341.5	281.5	234.0	NT	249.5	Mean	238.0	189.6	184.8	220.2	ND
		SD						SD	20.2	29.6	14.2	7.5	
		ratio	NA	0.82	0.69	NT	0.73	ratio	NA	0.80	0.78	0.93	
	-	Mean	331.0	319.5	253.5	NT	232.0	Mean	237.0	241.6	192.6	241.6	
		SD						SD	28.2	19.3	16.8	19.3	
		ratio	NA	0.97	0.77	NT	0.73	ratio	NA	1.02	0.81	1.02	
Finished water	+	Mean	341.5	244.0	244.0	NT	221.0	Mean	238.0	186.4	209.2	202.2	3.7
		SD						SD	20.2	14.0	9.8	18.95	
		ratio	NA	0.71	0.71	NT	0.65	ratio	NA	0.78	0.88	0.85	
	-	Mean	331.0	232.0	211.5	NT	171.0	Mean	237.0	240.2	221.2	229.0	
		SD						SD	28.2	16.3	24.7	17.5	
		ratio	NA	0.70	0.64	NT	0.52	ratio	NA	1.01	0.93	0.96	
Dist. I	+	Mean	341.5	230.0	217.0	NT	232.0	Mean	238.0	165.4	154.8	191.0	4.5
		SD						SD	20.2	12.1	23.2	16.3	
		ratio	NA	0.67	0.63	NT	0.68	ratio	NA	0.70	0.65	0.80	
	-	Mean	331.0	229.0	210.5	NT	205.5	Mean	237.0	213.0	208.6	196.6	
		SD						SD	28.2	16.1	4.6	14.1	
		ratio	NA	0.69	0.64	NT	0.62	ratio	NA	0.90	0.88	0.83	
Dist. II	+	Mean	341.5	241.5	253.5	NT	215.0	Mean	238.0	177.8	186.4	207.0	6.9
		SD						SD	20.2	24.1	30.2	13.1	
		ratio	NA	0.71	0.74	NT	0.63	ratio	NA	0.58	0.78	0.87	
	-	Mean	331.0	240.0	230.5	NT	232.5	Mean	237.0	215.2	185.0	205.2	
		SD						SD	28.2	23.2	7.2	10.6	
		ratio	NA	0.73	0.70	NT	0.70	ratio	NA	0.90	0.78	0.86	

Table 39. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Eau Claire, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	33.5	43.0	45.0	NT	44.0	Mean	104.0	86.2	89.4	69.2	ND
		SD						SD	4.36	13.6	8.35	3.90	
		ratio	NA	1.28	1.36	NT	1.31	ratio	NA	0.83	0.86	0.67	
	-	Mean	84.5	75.0	64.5	NT	59.5	Mean	90.8	75.4	100.0	105.4	
		SD						SD	20.0	8.3	7.4	15.4	
		ratio	NA	0.89	0.76	NT	0.70	ratio	NA	0.83	1.10	1.16	
Finished water	+	Mean	33.5	38.5	26.0	NT	48.0	Mean	104.0	95.8	98.4	79.4	3.7
		SD						SD	4.36	6.98	19.7	13.3	
		ratio	NA	1.15	0.77	NT	1.43	ratio	NA	0.92	0.95	0.76	
	-	Mean	84.5	78.0	83.5	NT	82.0	Mean	90.8	79.8	96.2	115.0	
		SD						SD	20.0	8.6	4.4	16.0	
		ratio	NA	0.92	0.99	NT	0.97	ratio	NA	0.88	1.06	1.27	
Dist. I	+	Mean	33.5	48.0	39.5	NT	41.5	Mean	104.0	87.4	92.4	79.4	4.5
		SD						SD	4.36	15.5	6.0	14.2	
		ratio	NA	1.43	1.18	NT	1.24	ratio	NA	0.84	0.89	0.76	
	-	Mean	84.5	70.5	65.5	NT	57.5	Mean	90.8	82.6	109.8	98.6	
		SD						SD	20.0	15.4	14.3	16.2	
		ratio	NA	0.83	0.78	NT	0.69	ratio	NA	0.91	1.21	1.09	
Dist. II	+	Mean	33.5	39.5	43.0	NT	48.0	Mean	104.0	93.0	96.0	89.2	6.9
		SD						SD	4.36	9.67	6.4	8.3	
		ratio	NA	1.18	1.28	NT	1.43	ratio	NA	0.89	0.92	0.86	
	-	Mean	84.5	71.0	61.5	NT	69.5	Mean	90.8	90.4	112.6	117.2	
		SD						SD	20.0	7.23	7.13	12.9	
		ratio	NA	0.84	0.73	NT	0.82	ratio	NA	1.00	1.24	1.29	

Table 40. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Eau Claire, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	NR	NR	NR	NR	ND
		SD	NT	NT	NT	NT	NT	SD	NR	NR	NR	NR	
		ratio						ratio	NR	NR	NR	NR	
	-	Mean	NT	NT	NT	NT	NT	Mean	NR	NR	NR	NR	
		SD	NT	NT	NT	NT	NT	SD	NR	NR	NR	NR	
		ratio						ratio	NR	NR	NR	NR	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	NR	NR	NR	NR	3.7
		SD	NT	NT	NT	NT	NT	SD	NR	NR	NR	NR	
		ratio						ratio	NR	NR	NR	NR	
	-	Mean	NT	NT	NT	NT	NT	Mean	NR	NR	NR	NR	
		SD	NT	NT	NT	NT	NT	SD	NR	NR	NR	NR	
		ratio						ratio	NR	NR	NR	NR	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	NR	NR	NR	NR	4.5
		SD	NT	NT	NT	NT	NT	SD	NR	NR	NR	NR	
		ratio						ratio	NR	NR	NR	NR	
	-	Mean	NT	NT	NT	NT	NT	Mean	NR	NR	NR	NR	
		SD	NT	NT	NT	NT	NT	SD	NR	NR	NR	NR	
		ratio						ratio	NR	NR	NR	NR	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	NR	NR	NR	NR	6.9
		SD	NT	NT	NT	NT	NT	SD	NR	NR	NR	NR	
		ratio						ratio	NR	NR	NR	NR	
	-	Mean	NT	NT	NT	NT	NT	Mean	NR	NR	NR	NR	
		SD	NT	NT	NT	NT	NT	SD	NR	NR	NR	NR	
		ratio						ratio	NR	NR	NR	NR	

Table 41. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Eau Claire, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	39.0	39.5	31.0	NT	35.5	Mean	65.8	66.6	75.8	87.8	ND
		ratio	NA	1.01	0.79	NT	0.91	SD	8.0	6.1	8.8	3.4	
								ratio	NA	1.01	1.15	1.33	
	-	Mean	28.5	36.5	40.5	NT	41.0	Mean	58.8	67.0	63.2	59.8	
		ratio	NA	1.28	1.42	NT	1.43	SD	9.5	14.1	9.6	5.9	
								ratio	NA	1.14	1.07	1.02	
Finished water	+	Mean	39.0	37.5	45.5	NT	43.0	Mean	65.8	67.8	73.2	72.2	3.7
		ratio	NA	0.96	1.17	NT	1.10	SD	8.0	8.8	10.6	11.1	
								ratio	NA	1.03	1.11	1.10	
	-	Mean	28.5	33.5	30.0	NT	43.0	Mean	58.8	54.6	58.0	59.8	
		ratio	NA	1.18	1.05	NT	1.51*	SD	4.5	6.3	8.66	7.9	
								ratio	NA	0.93	0.99	1.02	
Dist. I	+	Mean	39.0	36.5	38.0	NT	45.0	Mean	65.8	73.4	73.4	71.2	4.5
		ratio	NA	0.94	0.97	NT	1.15	SD	8.0	3.5	6.95	3.27	
								ratio	NA	1.12	1.12	1.08	
	-	Mean	28.5	34.0	43.0	NT	48.0	Mean	58.8	49.6	47.8	48.0	
		ratio	NA	1.19	1.51*	NT	1.68*	SD	4.5	2.4	2.3	6.2	
								ratio	NA	0.84	0.81	0.82	
Dist. II	+	Mean	39.0	34.5	39.0	NT	33.5	Mean	65.8	60.2	60.8	61.4	6.9
		ratio	NA	0.88	1.00	NT	0.86	SD	8.0	11.5	8.07	10.1	
								ratio	NA	0.91	0.92	0.93	
	-	Mean	28.5	44.5	32.5	NT	31.0	Mean	58.8	54.0	63.2	76.8	
		ratio	NA	1.56*	1.14	NT	1.09	SD	4.5	5.87	11.5	8.5	
								ratio	NA	0.92	1.07	1.31	

Table 42. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Fairborn, Ohio. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	90.0	69.5	63.0	58.0	47.5	Mean	111.8	108.4	104.8	66.7	ND
		SD	NA	0.77	0.70	0.64	0.53	SD	19.5	25.2	17.2	10.6	
		ratio						ratio	NA	0.97	0.94	0.60	
	-	Mean	80.5	62.0	72.5	132.5	98.0	Mean	94.2	91.4	102.4	112.4	
		SD	NA	0.77	0.90	1.65*	1.22	SD	13.3	23.4	24.7	27.7	
		ratio						ratio	NA	0.97	1.09	1.19	
Finished water	+	Mean	90.0	56.0	61.0	88.5	108.5	Mean	111.8	25.2	29.4	23.0	ND
		SD	NA	0.62	0.68	0.98	1.21	SD	19.5	4.50	5.2	2.3	
		ratio						ratio	NA	0.22	0.26	0.21	
	-	Mean	80.5	81.0	79.5	90.0	163.0	Mean	94.2	27.0	20.2	21.8	
		SD	NA	1.01	0.99	1.12	2.02**	SD	13.3	4.2	3.6	7.5	
		ratio						ratio	NA	0.29	0.21	0.23	
Dist. I	+	Mean	90.0	72.5	105.0	73.0	90.0	Mean	111.8	28.8	34.4	40.8	ND
		SD	NA	0.81	1.17	0.81	1.0	SD	19.5	10.3	5.8	9.6	
		ratio						ratio	NA	0.26	0.31	0.36	
	-	Mean	80.5	113.5	109.5	112.5	125.5	Mean	94.2	29.0	32.0	34.0	
		SD	NA	1.41	1.36	1.40	1.55*	SD	13.3	3.3	10.9	5.7	
		ratio						ratio	NA	0.31	0.34	0.36	
Dist. II	+	Mean	90.0	59.0	44.5	109.0	167.0	Mean	111.8	61.4	28.4	31.8	ND
		SD	NA	0.66	0.49	1.21	1.86*	SD	19.5	5.4	2.5	10.7	
		ratio						ratio	NA	0.55	0.25	0.28	
	-	Mean	80.5	66.0	35.5	155.5	170.0	Mean	94.2	47.4	25.4	28.0	
		SD	NA	0.82	0.44	1.93*	2.11**	SD	13.3	6.7	10.6	5.8	
		ratio						ratio	NA	0.50	0.27	0.30	

Table 43. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Fairborn, Ohio. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay, Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay, Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	325.0	322.0	297.0	259.5	271.5	Mean	310.2	191.4	272.6	272.0	ND
		SD						SD	30.9	23.4	20.8	70.0	
		ratio	NA	0.99	0.91	0.80	0.83	ratio	NA	0.61	0.88	0.88	
	-	Mean	318.0	293.5	307.5	259.5	259.0	Mean	315.2	248.4	208.4	284.8	
		SD						SD	21.9	35.3	35.6	36.3	
		ratio	NA	0.92	0.97	0.82	0.81	ratio	NA	0.79	0.67	0.90	
Finished water	+	Mean	325.0	353.0	372.0	331.5	286.5	Mean	310.2	82.4	94.0	83.0	ND
		SD						SD	30.9	5.4	34.1	16.8	
		ratio	NA	1.09	1.14	1.02	0.88	ratio	NA	0.27	0.30	0.27	
	-	Mean	318.0	253.5	307.0	327.0	357.5	Mean	315.2	95.2	95.0	142.2	
		SD						SD	21.9	7.22	9.4	17.7	
		ratio	NA	0.80	0.97	1.03	1.12	ratio	NA	0.30	0.30	0.45	
Dist. I	+	Mean	325.0	389.0	389.5	402.0	397.5	Mean	310.2	197.8	196.6	236.2	ND
		SD						SD	30.9	25.9	17.2	24.3	
		ratio	NA	1.20	1.20	1.24	1.22	ratio	NA	0.64	0.63	0.76	
	-	Mean	318.0	329.5	316.0	280.5	264.5	Mean	315.2	175.0	170.6	216.6	
		SD						SD	21.9	9.6	9.7	25.3	
		ratio	NA	1.04	0.99	0.88	0.83	ratio	NA	0.56	0.54	0.69	
Dist. II	+	Mean	325.0	403.5	332.5	311.5	303.5	Mean	310.2	124.8	75.2	110.8	ND
		SD						SD	30.9	4.9	8.9	35.7	
		ratio	NA	1.24	1.02	0.96	0.93	ratio	NA	0.40	0.24	0.36	
	-	Mean	318.0	351.0	312.0	294.0	360.5	Mean	315.2	126.8	101.2	84.0	
		SD						SD	21.9	4.2	18.1	6.2	
		ratio	NA	1.10	0.98	0.92	1.13	ratio	NA	0.40	0.32	0.27	

Table 44. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Fairborn, Ohio. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	70.5	72.0	84.5	81.5	69.0	Mean	57.2	110.0	92.4	98.0	ND
		SD						SD	13.1	60.7	57.0	34.4	
		ratio	NA	1.02	1.20	1.16	0.98	ratio	NA	1.92*	1.61*	1.36	
	-	Mean	64.5	61.0	65.0	89.0	65.5	Mean	83.4	109.8	99.4	78.6	
		SD						SD	6.1	56.7	44.3	33.8	
		ratio	NA	0.95	1.01	1.38	1.02	ratio	NA	1.32	1.19	0.99	
Finished water	+	Mean	70.5	76.5	82.5	63.5	80.0	Mean	57.2	60.2	77.8	81.0	ND
		SD						SD	13.1	7.9	16.2	36.7	
		ratio	NA	1.09	1.28	0.90	1.13		NA	1.05	1.36	1.42	
	-	Mean	64.5	59.0	74.0	95.5	87.5	Mean	83.4	61.4	59.2	61.2	
		SD						SD	6.1	23.5	9.2	9.8	
		ratio	NA	0.91	1.15	1.48	1.36	ratio	NA	0.74	0.71	0.73	
Dist. I	+	Mean	70.5	85.0	75.5	82.0	101.0	Mean	57.2	66.0	79.6	70.0	ND
		SD						SD	13.1	13.6	16.6	11.6	
		ratio	NA	1.21	1.07	1.16	1.43	ratio	NA	1.15	1.39	1.22	
	-	Mean	64.5	70.8	66.5	95.0	60.5	Mean	83.4	51.2	68.4	54.4	
		SD						SD	6.1	13.4	9.8	10.6	
		ratio	NA	1.09	1.03	1.35	0.94	ratio	NA	0.61	0.82	0.65	
Dist. II	+	Mean	70.5	78.5	70.0	59.5	79.0	Mean	57.2	74.0	58.4	76.8	ND
		SD						SD	13.1	9.0	10.9	12.5	
		ratio	NA	1.11	0.99	0.84	1.12	ratio	NA	1.29	1.02	1.34	
	-	Mean	64.5	61.0	79.5	100.0	62.5	Mean	83.4	69.2	64.0	63.4	
		SD						SD	6.1	6.3	2.2	8.73	
		ratio	NA	0.95	1.23	1.55*	0.97	ratio	NA	0.83	0.77	0.76	

Table 45. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Fairborn, Ohio. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	22.6	NT	17.8	24.6	ND
		ratio	NT	NT	NT	NT	NT	SD	4.9	NT	3.41	7.7	
								ratio	NA	NT	0.78	1.09	
	-	Mean	NT	NT	NT	NT	NT	Mean	12.6	NT	12.8	16.4	
		ratio	NT	NT	NT	NT	NT	SD	3.6	NT	3.6	1.5	
								ratio	NA	NT	1.02	1.30	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	22.6	24.2	21.0	23.6	ND
		ratio	NT	NT	NT	NT	NT	SD	4.9	6.3	3.9	9.07	
								ratio	NA	1.07	0.93	1.04	
	-	Mean	NT	NT	NT	NT	NT	Mean	12.6	16.4	15.0	13.6	
		ratio	NT	NT	NT	NT	NT	SD	3.6	8.3	4.2	1.8	
								ratio	NA	1.30	1.19	1.08	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	22.6	18.6	20.6	25.0	ND
		ratio	NT	NT	NT	NT	NT	SD	4.9	4.0	4.0	12.1	
								ratio	NA	0.82	0.91	1.11	
	-	Mean	NT	NT	NT	NT	NT	Mean	12.6	13.2	12.0	12.4	
		ratio	NT	NT	NT	NT	NT	SD	3.6	4.9	4.1	4.2	
								ratio	NA	1.05	0.95	0.98	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	22.6	17.6	25.4	27.6	ND
		ratio	NT	NT	NT	NT	NT	SD	4.9	6.6	6.1	9.6	
								ratio	NA	0.78	1.12	1.22	
	-	Mean	NT	NT	NT	NT	NT	Mean	12.6	22.0	15.4	22.2	
		ratio	NT	NT	NT	NT	NT	SD	3.6	9.8	2.1	8.58	
								ratio	NA	1.75*	1.22	1.76*	

Table 46. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Fairborn, Ohio. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	84.0	62.0	53.5	47.0	51.5	Mean	21.0	24.6	26.0	22.4	ND
		SD						SD	3.9	9.0	4.6	13.1	
		ratio	NA	0.74	0.64	0.56	0.61	ratio	NA	1.17	1.24	1.07	
	-	Mean	58.5	46.0	45.5	51.0	52.5	Mean	17.0	20.8	20.4	38.6	
		SD						SD	6.0	9.5	11.8	11.7	
		ratio	NA	0.79	0.76	0.87	0.90	ratio	NA	1.22	1.20	2.27**	
Finished water	+	Mean	84.0	91.5	109.0	34.5	36.0	Mean	21.0	26.2	35.0	74.7	ND
		SD						SD	3.9	1.64	11.2	37.7	
		ratio	NA	1.09	1.30	0.41	0.43	ratio	NA	1.25	1.67*	3.54**	
		Mean	58.5	70.5	58.5	37.0	34.0	Mean	17.0	14.4	14.0	30.6	
		SD						SD	6.0	5.0	2.8	12.9	
		ratio	NA	1.21	1.00	0.63	0.58	ratio	NA	0.84	0.82	1.80*	
Dist. I	+	Mean	84.0	88.5	73.5	68.0	65.0	Mean	21.0	37.4	41.6	38.6	ND
		SD						SD	3.9	12.8	10.1	14.1	
		ratio	NA	1.05	0.88	0.81	0.77	ratio	NA	1.78*	1.98*	1.84*	
	-	Mean	58.5	75.0	46.0	45.0	48.0	Mean	17.0	17.4	12.0	14.6	
		SD						SD	6.0	6.9	7.7	5.0	
		ratio	NA	1.28	0.79	0.77	0.82	ratio	NA	1.02	0.71	0.86	
Dist. II	+	Mean	84.0	196.5	183.5	244.0	253.5	Mean	21.0	20.4	25.2	25.6	ND
		SD						SD	3.9	5.2	9.3	7.4	
		ratio	NA	2.34**	2.18**	2.90**	3.02**	ratio	NA	0.97	1.20	1.22	
	-	Mean	58.5	207.0	241.5	192.0	75.0	Mean	17.0	15.6	14.0	12.4	
		SD						SD	6.0	2.4	4.4	5.9	
		ratio	NA	3.54**	4.13**	3.28**	1.28	ratio	NA	0.91	0.82	0.73	

Table 47. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Fayetteville, North Carolina. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	46.5	51.5	52.5	40.0	55.0	Mean	49.8	41.8	46.8	60.75	3.1
		SD						SD	8.35	3.90	11.63	14.38	
		ratio	NA	1.11	1.13	0.86	1.18	ratio	NA	0.84	0.94	1.22	
	-	Mean	41.5	47.0	33.0	39.5	32.0	Mean	39.0	38.0	38.4	38.2	
		SD						SD	11.66	3.54	7.86	11.78	
		ratio	NA	1.13	0.80	0.95	0.77	ratio	NA	0.97	0.98	0.98	
Finished water	+	Mean	46.5	42.5	41.5	40.5	55.5	Mean	49.8	50.2	37.4	55.4	0.2
		SD						SD	8.35	8.70	20.40	16.94	
		ratio	NA	0.93	0.89	0.87	1.19	ratio	NA	1.01	0.75	1.11	
	-	Mean	41.5	29.0	43.5	32.5	42.5	Mean	39.0	37.2	41.4	42.8	
		SD						SD	11.66	4.02	8.47	10.94	
		ratio	NA	0.70	1.05	0.78	1.02	ratio	NA	0.95	1.06	1.10	
Dist. I	+	Mean	46.5	34.5	52.0	46.0	38.0	Mean	49.8	54.4	56.2	70.2	1.6
		SD						SD	8.35	24.97	8.17	7.98	
		ratio	NA	0.74	1.12	0.99	0.82	ratio	NA	1.09	1.13	1.41	
	-	Mean	41.5	37.5	40.0	44.5	35.0	Mean	39.0	46.8	49.4	50.6	
		SD						SD	11.66	9.86	8.44	6.19	
		ratio	NA	0.90	0.96	1.07	0.84	ratio	NA	1.20	1.27	1.30	
Dist. II	+	Mean	46.5	37.0	47.5	42.5	51.0	Mean	49.8	48.8	54.6	57.2	2.1
		SD						SD	8.35	2.17	7.44	7.09	
		ratio	NA	0.80	1.02	0.91	1.10	ratio	NA	0.98	1.10	1.15	
	-	Mean	41.5	38.5	33.0	46.0	62.5	Mean	39.0	43.4	53.0	68.8	
		SD						SD	11.66	3.78	19.13	38.64	
		ratio	NA	0.93	0.80	1.11	1.51*	ratio	NA	1.11	1.36	1.76*	

Table 48. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Fayetteville, North Carolina. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	126.0	99.0	107.0	117.0	127.0	Mean	145.8	136.2	138.4	136.0	3.1
		SD						SD	7.82	14.57	17.98	17.26	
		ratio	NA	0.79	0.85	0.93	1.01	ratio	NA	0.93	0.95	0.93	
	-	Mean	145.0	163.5	127.0	121.0	114.0	Mean	163.8	149.6	148.6	142.6	
		SD						SD	10.52	1.26	7.40	13.20	
		ratio	NA	1.13	0.88	0.83	0.77	ratio	NA	0.91	0.91	0.87	
Finished water	+	Mean	126.0	117.5	125.0	124.5	107.0	Mean	145.8	119.0	149.2	146.4	0.2
		SD						SD	7.82	11.66	13.54	13.37	
		ratio	NA	0.93	0.99	0.99	0.85	ratio	NA	0.82	1.02	1.00	
	-	Mean	145.0	126.0	136.5	117.0	121.0	Mean	163.8	136.4	136.8	151.8	
		SD						SD	10.52	10.29	9.50	18.36	
		ratio	NA	0.87	0.94	0.81	0.83	ratio	NA	0.83	0.84	0.93	
Dist. I	+	Mean	126.0	120.0	122.0	112.0	109.0	Mean	145.8	151.8	162.0	143.6	1.6
		SD						SD	7.82	10.71	14.34	5.90	
		ratio	NA	0.95	0.97	0.89	0.87	ratio	NA	1.04	1.11	0.98	
	-	Mean	145.0	147.0	142.0	154.5	136.0	Mean	163.8	170.6	134.0	170.8	
		SD						SD	10.52	16.86	14.26	17.25	
		ratio	NA	1.01	0.98	1.07	0.94	ratio	NA	1.04	0.81	1.04	
Dist. II	+	Mean	126.0	113.0	130.0	137.5	93.0	Mean	145.8	133.4	135.8	124.8	2.1
		SD						SD	7.82	9.23	9.96	16.67	
		ratio	NA	0.90	1.03	1.09	0.74	ratio	NA	0.91	0.93	0.86	
	-	Mean	145.0	131.5	146.5	158.0	160.5	Mean	163.8	131.0	146.4	120.0	
		SD						SD	10.52	11.14	17.29	8.23	
		ratio	NA	0.91	1.01	1.09	1.11	ratio	NA	0.80	0.89	0.89	

Table 49. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Fayetteville, North Carolina. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	39.0	59.5	66.5	58.0	36.0	Mean	68.2	50.6	44.5	69.8	3.1
		SD						SD	11.2	15.76	14.20	8.07	
		ratio	NA	1.53*	1.71*	1.49	0.92	ratio	NA	0.74	0.65	1.02	
	-	Mean	86.5	103.5	94.0	103.0	118.0	Mean	110.0	88.4	70.4	80.4	
		SD						SD	15.0	17.71	8.71	9.21	
		ratio	NA	1.20	1.09	1.19	1.36	ratio	NA	0.80	0.64	0.73	
Finished water	+	Mean	39.0	34.5	20.0	26.0	31.5	Mean	68.2	62.2	57.6	55.0	0.2
		SD						SD	11.2	12.68	11.37	13.69	
		ratio	NA	0.88	0.51	0.67	0.81	ratio	NA	0.91	0.84	0.81	
	-	Mean	86.5	93.5	85.5	60.5	89.0	Mean	110.0	105.6	78.8	71.4	
		SD						SD	15.0	16.10	5.67	7.09	
		ratio	NA	1.08	0.99	0.70	1.03	ratio	NA	0.96	0.72	0.65	
Dist. I	+	Mean	39.0	23.0	41.0	47.0	46.0	Mean	68.2	65.0	71.0	66.4	1.6
		SD						SD	11.2	3.39	7.78	10.85	
		ratio	NA	0.59	1.05	1.21	1.18	ratio	NA	0.95	1.04	0.97	
	-	Mean	86.5	87.0	63.5	37.5	35.5	Mean	110.0	88.6	91.8	89.2	
		SD						SD	15.0	9.79	10.89	16.65	
		ratio	NA	1.01	0.73	0.43	0.41	ratio	NA	0.81	0.83	0.81	
Dist. II	+	Mean	39.0	29.0	44.5	29.5	30.0	Mean	68.2	53.8	58.8	83.2	2.1
		SD						SD	11.2	3.56	9.55	8.79	
		ratio	NA	0.74	1.14	0.75	0.77	ratio	NA	0.79	0.86	1.22	
	-	Mean	86.5	68.0	62.0	25.5	20.5	Mean	110.0	90.4	96.6	113.2	
		SD						SD	15.0	23.58	7.30	11.69	
		ratio	NA	0.79	0.71	0.29	0.24	ratio	NA	0.82	0.88	1.03	

Table 50. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Fayetteville, North Carolina. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	26.8	23.2	26.2	28.2	3.1
		ratio	NT	NT	NT	NT	NT	SD	6.87	6.53	4.82	6.72	
								ratio	NA	0.87	0.98	1.05	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.2	18.0	16.2	18.0	
		ratio	NT	NT	NT	NT	NT	SD	2.49	3.54	2.68	4.53	
								ratio	NA	1.05	0.94	1.05	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	26.8	28.0	22.2	21.2	0.2
		ratio	NT	NT	NT	NT	NT	SD	6.87	9.03	4.44	7.79	
								ratio	NA	1.04	0.83	0.79	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.2	16.6	28.0	23.6	
		ratio	NT	NT	NT	NT	NT	SD	2.49	2.61	10.05	8.68	
								ratio	NA	0.97	1.63*	1.37	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	26.8	23.0	23.0	27.6	1.6
		ratio	NT	NT	NT	NT	NT	SD	6.87	3.08	5.48	8.26	
								ratio	NA	0.86	0.86	1.03	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.2	21.6	22.8	21.4	
		ratio	NT	NT	NT	NT	NT	SD	2.49	10.69	12.77	5.59	
								ratio	NA	1.26	1.33	1.24	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	26.8	24.0	31.4	34.6	2.1
		ratio	NT	NT	NT	NT	NT	SD	6.87	8.94	6.08	2.88	
								ratio	NA	0.90	1.17	1.29	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.2	22.2	31.0	25.2	
		ratio	NT	NT	NT	NT	NT	SD	2.49	3.42	8.97	9.68	
								ratio	NA	1.29	1.16	1.47	

Table 51. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Fayetteville, North Carolina. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	35.0	18.5	31.0	18.5	28.5	Mean	26.40	24.6	32.8	31.4	3.1
		SD						SD	2.07	8.44	5.16	4.72	
		ratio	NA	0.52	0.89	0.53	0.81	ratio	NA	0.93	1.24	1.19	
	-	Mean	12.0	14.0	15.0	15.5	21.0	Mean	27.6	17.6	21.6	13.8	
		SD						SD	2.70	7.37	4.62	5.07	
		ratio	NA	1.17	1.25	1.29	1.75*	ratio	NA	0.64	0.78	0.50	
Finished water	+	Mean	35.0	23.0	23.0	25.5	20.0	Mean	26.40	21.4	34.6	31.8	0.2
		SD						SD	2.07	4.34	5.32	10.57	
		ratio	NA	0.66	0.65	0.73	0.57	ratio	NA	0.81	1.31	1.20	
	-	Mean	12.0	13.0	18.5	22.5	23.0	Mean	27.6	25.4	27.6	25.0	
		SD						SD	2.70	8.14	5.77	6.28	
		ratio	NA	0.50	0.54	0.53	0.96	ratio	NA	0.92	1.00	0.91	
Dist. I	+	Mean	35.0	17.5	19.0	18.5	33.5	Mean	26.40	25.2	32.8	31.8	1.6
		SD						SD	2.07	5.07	5.54	8.23	
		ratio	NA	0.50	0.54	0.53	0.96	ratio	NA	0.95	1.24	1.20	
	-	Mean	12.0	10.5	12.5	10.0	15.5	Mean	27.6	26.0	31.0	23.4	
		SD						SD	2.70	3.54	8.15	4.10	
		ratio	NA	0.85	1.04	0.83	1.29	ratio	NA	0.94	1.12	0.85	
Dist. II	+	Mean	35.0	22.5	18.0	29.0	22.5	Mean	26.40	28.0	35.4	38.6	2.1
		SD						SD	2.07	5.96	7.40	10.95	
		ratio	NA	0.64	0.51	0.83	0.64	ratio	NA	1.06	1.34	1.46	
	-	Mean	12.0	18.0	16.0	13.0	20.0	Mean	27.6	22.4	32.2	32.0	
		SD						SD	2.70	7.73	6.34	7.91	
		ratio	NA	1.50*	1.58*	1.08	1.67*	ratio	NA	0.81	1.17	1.16	

Table 52. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Fond du Lac, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	60.5	77.0	70.0	NT	79.5	Mean	58.0	61.4	58.0	43.4	0.7
		ratio	NA	1.27	1.16	NT	1.31	SD	3.67	9.5	7.07	6.98	
								ratio	NA	1.06	1.0	0.75	
	-	Mean	85.0	98.5	86.0	NT	86.0	Mean	46.0	41.2	46.0	44.0	
		ratio	NA	1.16	1.01	NT	1.01	SD	3.0	8.2	4.18	9.4	
								ratio	NA	0.90	1.0	0.96	
Finished water	+	Mean	60.5	74.5	79.0	NT	75.5	Mean	58.0	69.0	66.8	60.0	13.4
		ratio	NA	1.23	1.31	NT	1.25	SD	3.67	5.24	6.06	4.89	
								ratio	NA	1.19	1.15	1.03	
	-	Mean	85.0	85.0	81.0	NT	96.5	Mean	46.0	61.8	57.0	55.4	
		ratio	NA	1.00	0.95	NT	1.14	SD	3.0	5.8	16.5	4.98	
								ratio	NA	1.34	1.24	1.20	
Dist. I	+	Mean	60.5	84.0	42.5	NT	61.5	Mean	58.0	72.8	63.2	69.2	0.3
		ratio	NA	1.39	0.70	NT	1.02	SD	3.67	2.39	8.32	10.1	
								ratio	NA	1.26	1.09	1.19	
	-	Mean	85.0	64.5	61.5	NT	67.5	Mean	46.0	55.4	63.6	55.0	
		ratio	NA	0.76	0.72	NT	0.79	SD	3.0	5.4	6.20	6.59	
								ratio	NA	1.20	1.38	1.20	
Dist. II	+	Mean	60.5	71.0	80.0	NT	76.0	Mean	58.0	68.6	78.8	74.4	3.1
		ratio	NA	1.17	1.32	NT	1.26	SD	3.67	4.04	13.5	13.40	
								ratio	NA	1.18	1.36	1.28	
	-	Mean	85.0	88.0	69.5	NT	74.0	Mean	46.0	48.0	59.2	50.8	
		ratio	NA	1.04	0.82	NT	0.87	SD	3.0	5.60	3.56	5.02	
								ratio	NA	1.04	1.29	1.10	

Table 53. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Fond du Lac, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	270.5	300.0	250.5	NT	315.5	Mean	286.4	244.8	292.6	287.2	0.7
		SD	NA			NT		SD	22.97	11.1	19.5	20.9	
		ratio		1.11	0.93		1.17	ratio	NA	0.86	1.02	1.00	
	-	Mean	317.0	380.0	321.5	NT	322.0	Mean	262.6	286.4	236.8	272.0	
		SD	NA			NT		SD	17.70	18.5	12.8	24.6	
		ratio		1.20	1.01		1.02	ratio	NA	1.09	0.90	1.04	
Finished water	+	Mean	270.5	268.5	291.0	NT	299.0	Mean	286.4	268.8	276.2	276.2	13.4
		SD	NA			NT		SD	22.97	35.4	29.9	16.3	
		ratio		0.99	1.08		1.11	ratio	NA	0.94	0.96	0.96	
	-	Mean	317.0	290.5	313.5	NT	343.0	Mean	262.6	286.8	245.2	253.4	
		SD	NA			NT		SD	17.70	10.0	14.9	12.3	
		ratio		0.92	0.99		1.08	ratio	NA	1.09	0.97	0.97	
Dist. I	+	Mean	270.5	288.5	301.5	NT	288.0	Mean	286.4	240.2	270.8	286.0	0.3
		SD	NA			NT		SD	22.97	14.50	8.20	25.5	
		ratio		1.06	1.11		1.06	ratio	NA	0.84	0.95	1.00	
	-	Mean	317.0	337.0	309.0	NT	320.0	Mean	262.6	275.4	247.6	246.8	
		SD	NA			NT		SD	17.70	8.62	17.6	19.4	
		ratio		1.06	0.97		1.01	ratio	NA	1.05	0.94	0.94	
Dist. II	+	Mean	270.5	326.0	342.0	NT	317.5	Mean	286.4	240.2	270.8	286.0	3.1
		SD	NA			NT		SD	22.97	14.50	8.20	25.5	
		ratio		1.21	1.26		1.17	ratio	NA	0.84	0.95	1.00	
	-	Mean	317.0	351.5	326.0	NT	353.5	Mean	262.6	275.4	247.6	246.8	
		SD	NA			NT		SD	17.70	8.62	17.6	19.4	
		ratio		1.11	1.03		1.12	ratio	NA	1.05	0.94	0.94	

Table 54. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Fond du Lac, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	31.5	46.0	43.0	NT	31.5	Mean	170.8	105.8	78.0	79.8	0.7
		SD						SD	12.7	9.2	7.2	10.3	
		ratio	NA	1.46	1.37	NT	1.00	ratio	NA	0.62	0.46	0.47	
	-	Mean	71.5	44.5	51.0	NT	47.5	Mean	132.0	111.4	77.4	79.8	
		SD						SD	15.3	14..9	4.6	7.2	
		ratio	NA	0.62	0.71	NT	0.66	ratio	NA	0.84	0.59	0.61	
Finished water	+	Mean	31.5	28.5	40.5	NT	35.5	Mean	170.8	123.0	114.0	97.6	13.4
		SD						SD	12.7	17.7	13.9	12.3	
		ratio	NA	0.90	1.29	NT	1.13	ratio	NA	0.72	0.67	0.57	
	-	Mean	71.5	44.5	78.5	NT	62.0	Mean	132.0	154.6	101.0	74.6	
		SD						SD	15.3	29.9	12.4	10.1	
		ratio	NA	0.62	1.10	NT	0.87	ratio	NA	1.17	0.77	0.57	
Dist. I	+	Mean	31.5	49.0	40.0	NT	55.0	Mean	170.8	133.0	113.4	144.6	0.3
		SD						SD	12.7	13.7	14.8	14.2	
		ratio	NA	1.56*	1.27	NT	1.75*	ratio	NA	0.78	0.66	0.85	
	-	Mean	71.5	84.0	80.5	NT	75.0	Mean	132.0	148.8	103.4	107.4	
		SD						SD	15.3	23.3	11.6	11.9	
		ratio	NA	1.17	1.13	NT	1.05	ratio	NA	1.13	0.78	0.81	
Dist. II	+	Mean	31.5	41.5	45.0	NT	53.5	Mean	170.8	117.0	134.0	144.4	3.1
		SD						SD	12.7	9.97	31.1	19.5	
		ratio	NA	1.32	1.43	NT	1.70*	ratio	NA	0.69	0.79	0.85	
	-	Mean	71.5	75.5	76.5	NT	86.0	Mean	132.0	142.6	108.6	119.4	
		SD						SD	15.3	18.4	5.3	17.3	
		ratio	NA	1.06	1.07	NT	1.20	ratio	NA	1.08	0.82	0.91	

Table 55. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Fond du Lac, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay, Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay, Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	36.8	27.4	19.8	21.2	0.7
		ratio	NT	NT	NT	NT	NT	SD	11.1	4.0	4.9	12.0	
								ratio	NA	0.75	0.15	0.58	
	-	Mean	NT	NT	NT	NT	NT	Mean	39.8	8.6	22.0	19.8	
		ratio	NT	NT	NT	NT	NT	SD	9.52	2.6	5.34	4.9	
								ratio	NA	0.22	0.55	0.50	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	36.8	36.2	130.8	136.4	13.4
		ratio	NT	NT	NT	NT	NT	SD	11.1	4.3	46.6	31.9	
								ratio	NA	0.98	3.55**	3.71**	
	-	Mean	NT	NT	NT	NT	NT	Mean	39.8	39.4	34.8	28.6	
		ratio	NT	NT	NT	NT	NT	SD	9.52	5.5	7.0	5.3	
								ratio	NA	0.99	0.87	0.72	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	36.8	70.2	31.0	108.0	0.3
		ratio	NT	NT	NT	NT	NT	SD	11.1	27.3	4.2	21.6	
								ratio	NA	1.91*	0.84	2.93**	
	-	Mean	NT	NT	NT	NT	NT	Mean	39.8	37.0	32.0	30.6	
		ratio	NT	NT	NT	NT	NT	SD	9.52	6.0	6.67	5.2	
								ratio	NA	0.93	0.80	0.77	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	36.8	71.2	106.8	39.4	3.1
		ratio	NT	NT	NT	NT	NT	SD	11.1	26.5	26.5	20.6	
								ratio	NA	1.93*	2.90**	1.07	
	-	Mean	NT	NT	NT	NT	NT	Mean	39.8	36.8	25.2	21.0	
		ratio	NT	NT	NT	NT	NT	SD	9.52	5.4	5.2	6.4	
								ratio	NA	0.93	0.63	0.53	

Table 56. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Fond du Lac, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	22.5	26.0	24.5	NT	19.5	Mean	39.2	23.8	27.2	48.2	0.7
		SD				NT		SD	6.1	6.06	7.2	3.96	
		ratio	NA	1.16	1.09		0.87	ratio	NA	0.61	0.69	1.23	
	-	Mean	29.0	25.5	15.0	NT	18.0	Mean	22.2	24.4	14.6	15.6	
		SD				NT		SD	8.04	4.3	5.6	4.3	
		ratio	NA	0.88	0.52		0.62	ratio	NA	1.10	0.66	0.70	
Finished water	+	Mean	22.5	28.0	24.0	NT	27.0	Mean	39.2	49.4	56.0	74.0	13.4
		SD				NT		SD	6.1	5.5	8.6	20.4	
		ratio	NA	1.24	1.07		1.20	ratio	NA	1.26	1.43	1.89*	
	-	Mean	29.0	21.5	18.5	NT	26.0	Mean	22.2	21.4	17.8	12.4	
		SD				NT		SD	8.04	5.3	6.06	4.3	
		ratio	NA	0.74	0.64		0.89	ratio	NA	0.96	0.80	0.59	
Dist. I	+	Mean	22.5	28.5	18.0	NT	24.0	Mean	39.2	58.4	65.0	72.0	0.3
		SD				NT		SD	6.1	10.0	6.56	28.1	
		ratio	NA	1.27	0.80		1.07	ratio	NA	1.49	1.66*	1.84*	
	-	Mean	29.0	27.0	25.5	NT	18.5	Mean	22.2	19.6	22.4	19.0	
		SD				NT		SD	8.04	4.8	6.5	1.73	
		ratio	NA	0.93	0.88		0.64	ratio	NA	0.88	1.01	0.86	
Dist. II	+	Mean	22.5	32.5	31.0	NT	31.5	Mean	39.2	64.4	68.8	69.4	3.1
		SD				NT		SD	6.1	15.6	9.1	6.84	
		ratio	NA	1.44	1.36		1.40	ratio	NA	1.64*	1.76*	1.77*	
	-	Mean	29.0	22.5	30.0	NT	30.5	Mean	22.2	24.2	20.6	27.0	
		SD				NT		SD	8.04	2.95	6.5	8.6	
		ratio	NA	0.78	1.03		1.05	ratio	NA	1.09	0.93	1.22	

Table 57. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Fort Meyers, Florida (I). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	31.0	17.0	21.0	NT	47.0	Mean	63.2	55.0	64.0	54.0	ND
		SD						SD	8.93	4.58	7.45	7.58	
		ratio	NA	0.55	0.68	NT	1.52*	ratio	NA	0.87	1.01	0.85	
	-	Mean	44.0	20.0	30.0	NT	44.0	Mean	53.6	47.8	54.2	42.0	
		SD						SD	8.68	5.22	6.98	8.28	
		ratio	NA	0.45	0.68	NT	1.0	ratio	NA	0.89	1.01	0.78	
Finished water	+	Mean	31.0	39.0	32.0	NT	26.0	Mean	63.2	57.4	58.4	52.6	0.8
		SD						SD	8.93	10.14	4.72	7.54	
		ratio	NA	1.26	1.03	NT	0.84	ratio	NA	0.87	0.92	0.83	
	-	Mean	44.0	44.0	41.0	NT	25.0	Mean	53.6	47.8	46.6	50.2	
		SD						SD	8.68	6.0	10.47	11.43	
		ratio	NA	1.0	0.93	NT	0.45	ratio	NA	0.89	0.74	0.94	
Dist. I	+	Mean	31.0	38.0	33.0	NT	24.0	Mean	63.2	51.4	59.8	60.0	ND
		SD						SD	8.93	6.39	11.88	8.06	
		ratio	NA	1.23	1.06	NT	0.77	ratio	NA	0.81	0.95	0.95	
	-	Mean	44.0	42.0	47.0	NT	42.0	Mean	53.6	46.8	46.2	48.6	
		SD						SD	8.68	3.63	5.89	5.41	
		ratio	NA	0.95	1.07	NT	0.95	ratio	NA	0.87	0.86	0.91	
Dist. II	+	Mean	31.0	37.0	30.0	NT	40.0	Mean	63.2	44.2	57.2	50.0	4.7
		SD						SD	8.93	7.33	6.87	4.74	
		ratio	NA	1.19	0.97	NT	1.29	ratio	NA	0.70	0.91	0.79	
	-	Mean	44.0	51.0	41.0	NT	40.0	Mean	53.6	53.8	55.6	45.0	
		SD						SD	8.68	10.57	9.40	7.68	
		ratio	NA	1.16	0.93	NT	0.91	ratio	NA	1.00	1.04	0.84	

Table 58. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Fort Meyers, Florida (I). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay, Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay, Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	285.0	168.0	193.0	NT	277.0	Mean	281.0	267.8	248.6	260.6	ND
		SD				NT		SD	35.2	56.35	22.3	30.88	
		ratio	NA	0.59	0.68		0.97	ratio	NA	0.95	0.89	0.93	
	-	Mean	249.0	240.0	190.0	NT	257.0	Mean	222.0	258.6	242.6	258.8	
		SD				NT		SD	65.1	7.70	11.65	24.37	
		ratio	NA	0.96	0.76		1.03	ratio	NA	1.17	1.09	1.17	
Finished water	+	Mean	285.0	355.0	320.0	NT	266.0	Mean	281.0	249.4	256.8	250.8	0.8
		SD				NT		SD	35.2	23.3	27.47	19.38	
		ratio	NA	1.25	1.12		0.93	ratio	3.92	0.89	0.91	0.89	
	-	Mean	249.0	278.0	270.0	NT	223.0	Mean	222.0	239.8	254.8	273.0	
		SD				NT		SD	65.1	29.41	17.18	16.78	
		ratio	NA	1.12	1.08		0.89	ratio	NA	1.08	1.15	1.23	
Dist. I	+	Mean	285.0	339.0	323.0	NT	307.0	Mean	281.0	236.0	262.8	258.4	ND
		SD				NT		SD	35.2	14.46	8.35	7.89	
		ratio	NA	1.19	1.13		1.08	ratio	NA	0.84	0.94	0.92	
	-	Mean	249.0	374.0	273.0	NT	245.0	Mean	222.0	200.2	253.8	281.0	
		SD				NT		SD	65.1	17.25	26.17	9.51	
		ratio	NA	1.10	1.10		0.98	ratio	NA	0.90	1.14	1.27	
Dist. II	+	Mean	285.0	302.0	344.0	NT	331.0	Mean	281.0	239.6	281.6	267.8	4.7
		SD				NT		SD	35.2	11.89	13.94	18.97	
		ratio	NA	1.06	1.21		1.16	ratio	NA	0.85	1.00	0.95	
	-	Mean	249.0	236.0	253.0	NT	257.0	Mean	222.0	213.4	269.4	281.6	
		SD				NT		SD	65.1	24.72	19.14	23.18	
		ratio	NA	0.95	1.02		1.03	ratio	NA	0.96	1.21	1.27	

Table 59. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Fort Meyers, Florida (I). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	66.0	43.0	34.0	NT	74.0	Mean	55.4	43.8	50.4	31.6	ND
		ratio	NA	0.65	0.51	NT	1.12	SD	9.79	11.92	11.89	7.96	
								ratio	NA	0.79	0.91	0.57	
	-	Mean	31.0	28.0	35.0	NT	25.0	Mean	49.2	32.2	38.8	29.6	
		ratio	NA	0.90	1.13	NT	0.81	SD	6.01	14.0	3.49	8.26	
								ratio	NA	0.65	0.79	0.60	
Finished water	+	Mean	66.0	65.0	55.0	NT	61.0	Mean	55.4	55.0	61.2	58.0	0.8
		ratio	NA	0.98	0.83	NT	0.92	SD	9.79	9.80	23.78	17.52	
								ratio	NA	0.99	1.10	1.05	
	-	Mean	31.0	25.0	23.0	NT	28.0	Mean	49.2	49.2	59.6	61.6	
		ratio	NA	0.81	0.74	NT	0.90	SD	6.01	16.8	14.28	14.79	
								ratio	NA	0.89	1.21	1.25	
Dist. I	+	Mean	66.0	67.0	67.0	NT	60.0	Mean	55.4	58.8	81.0	67.2	ND
		ratio	NA	1.02	1.02	NT	0.91	SD	9.79	11.08	16.06	12.66	
								ratio	NA	1.06	1.46	1.21	
	-	Mean	31.0	30.0	33.0	NT	34.0	Mean	49.2	56.2	67.0	79.0	
		ratio	NA	0.97	1.06	NT	1.10	SD	6.01	4.92	8.54	12.98	
								ratio	NA	1.14	1.36	1.61*	
Dist. II	+	Mean	66.0	62.0	76.0	NT	77.0	Mean	55.4	58.0	64.6	66.2	4.7
		ratio	NA	0.94	1.16	NT	1.17	SD	9.79	9.82	11.24	8.90	
								ratio	NA	1.05	1.17	1.20	
	-	Mean	31.0	24.0	28.0	NT	30.0	Mean	49.2	51.8	65.0	64.8	
		ratio	NA	0.77	0.90	NT	0.97	SD	6.01	10.96	10.17	8.22	
								ratio	NA	1.05	1.32	1.32	

Table 60. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Fort Meyers, Florida (I). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	13.0	13.6	26.2	41.4	ND
		SD	NT	NT	NT	NT	NT	SD	2.74	3.21	5.45	12.52	
		ratio						ratio	NA	1.05	2.02**	3.18**	
	-	Mean	NT	NT	NT	NT	NT	Mean	13.8	15.8	20.8	40.2	
		SD	NT	NT	NT	NT	NT	SD	3.11	7.05	6.38	14.55	
		ratio						ratio	NA	1.14	1.51*	2.91**	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	13.0	11.0	28.6	34.6	0.8
		SD	NT	NT	NT	NT	NT	SD	2.74	2.92	7.54	5.90	
		ratio						ratio	NA	0.85	2.2**	2.66**	
	-	Mean	NT	NT	NT	NT	NT	Mean	13.8	11.2	22.2	31.8	
		SD	NT	NT	NT	NT	NT	SD	3.11	3.77	10.13	10.11	
		ratio						ratio	NA	0.81	1.61*	2.30**	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	13.0	13.6	15.6	19.4	ND
		SD	NT	NT	NT	NT	NT	SD	2.74	3.05	3.91	6.69	
		ratio						ratio	NA	1.05	1.2	1.49	
	-	Mean	NT	NT	NT	NT	NT	Mean	13.8	12.4	13.3	21.2	
		SD	NT	NT	NT	NT	NT	SD	3.11	2.97	3.08	6.57	
		ratio						ratio	NA	0.90	0.97	1.54*	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	13.0	12.6	26.0	20.0	4.7
		SD	NT	NT	NT	NT	NT	SD	2.74	2.97	8.22	5.29	
		ratio						ratio	NA	0.97	2.0**	1.54*	
	-	Mean	NT	NT	NT	NT	NT	Mean	13.8	11.0	13.0	16.6	
		SD	NT	NT	NT	NT	NT	SD	3.11	1.58	3.54	6.88	
		ratio						ratio	NA	0.80	0.94	1.20	

Table 61. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Fort Meyers, Florida (I). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	34.0	19.0	19.0	NT	41.0	Mean	38.6	61.4	51.0	54.2	ND
		SD						SD	7.06	8.32	6.04	7.50	
		ratio	NA	0.56	0.56	NT	1.21	ratio	NA	1.59*	1.32	1.40	
	-	Mean	53.0	21.0	38.0	NT	38.0	Mean	44.4	44.4	43.2	39.0	
		SD						SD	4.39	9.45	4.76	5.43	
		ratio	NA	0.4	0.72	NT	0.72	ratio	NA	1.0	0.97	0.88	
Finished water	+	Mean	34.0	28.0	25.0	NT	21.0	Mean	38.6	45.2	45.4	47.8	0.8
		SD						SD	7.06	6.76	11.33	4.87	
		ratio	NA	0.82	0.74	NT	0.62	ratio	NA	1.17	1.18	1.24	
		Mean	53.0	47.0	42.0	NT	40.0	Mean	44.4	36.0	34.6	40.4	
		SD						SD	4.39	4.42	3.91	11.91	
		ratio	NA	0.89	0.79	NT	0.75	ratio	NA	0.81	0.78	0.91	
Dist. I	+	Mean	34.0	31.0	38.0	NT	26.0	Mean	38.6	52.4	60.0	52.0	ND
		SD						SD	7.06	8.91	11.58	6.63	
		ratio	NA	0.91	1.12	NT	0.76	ratio	NA	1.36	1.55*	1.35	
	-	Mean	53.0	35.0	38.0	NT	40.0	Mean	44.4	39.8	46.4	39.2	
		SD						SD	4.39	8.20	6.43	3.96	
		ratio	NA	0.66	0.72	NT	0.75	ratio	NA	0.90	1.05	0.88	
Dist. II	+	Mean	34.0	38.0	30.0	NT	29.0	Mean	38.6	54.2	54.2	37.2	4.7
		SD						SD	7.06	10.4	7.12	8.84	
		ratio	NA	1.12	0.88	NT	0.85	ratio	NA	1.40	1.40	0.96	
	-	Mean	53.0	49.0	44.0	NT	35.0	Mean	44.4	38.2	46.8	31.6	
		SD						SD	4.39	6.38	4.60	7.80	
		ratio	NA	0.92	0.83	NT	0.66	ratio	NA	0.86	1.05	0.71	

Table 62. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Fort Meyers, Florida (II). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	113.5	25.0	20.5	29.0	19.0	Mean	135.0	104.8	85.4	72.8	ND
		SD						SD	6.1	12.5	11.0	15.3	
		ratio	NA	0.22	0.18	0.26	0.17	ratio	NA	0.76	0.63	0.54	
	-	Mean	130.5	47.0	15.0	39.0	37.5	Mean	69.8	70.8	52.0	42.8	
		SD						SD	8.9	16.0	13.0	6.5	
		ratio	NA	0.36	0.11	0.30	0.29	ratio	NA	1.01	0.74	0.61	
Finished water	+	Mean	113.5	97.0	41.0	27.5	20.5	Mean	135.0	90.0	120.6	138.4	4.7
		SD						SD	6.1	9.2	12.6	8.8	
		ratio	NA	0.85	0.36	0.24	0.18	ratio	NA	0.67	0.89	1.03	
	-	Mean	130.5	86.0	16.5	36.0	30.5	Mean	69.8	94.8	104.6	135.2	
		SD						SD	8.9	24.5	30.7	3.9	
		ratio	NA	0.66	0.12	0.28	0.23	ratio	NA	1.36	1.49	1.94*	
Dist. I	+	Mean	113.5	62.0	49.0	35.0	47.5	Mean	135.0	97.6	103.8	147.6	6.4
		SD						SD	6.1	16.8	9.7	9.8	
		ratio	NA	0.55	0.43	0.26	0.42	ratio	NA	0.72	0.77	1.09	
	-	Mean	130.5	79.0	59.0	56.5	33.5	Mean	69.8	82.8	104.0	132.0	
		SD						SD	8.9	13.9	10.5	6.2	
		ratio	NA	0.61	0.45	0.43	0.26	ratio	NA	1.18	1.49	1.89*	
Dist. II	+	Mean	113.5	81.0	51.0	58.5	55.0	Mean	135.0	116.4	163.2	176.2	2.0
		SD						SD	6.1	8.1	6.7	8.3	
		ratio	NA	0.71	0.45	0.52	0.48	ratio	NA	0.86	1.21	1.30	
	-	Mean	130.5	58.5	43.0	41.5	39.0	Mean	69.8	100.8	125.8	146.6	
		SD						SD	8.9	8.0	15.9	13.1	
		ratio	NA	0.45	0.33	0.32	0.30	ratio	NA	1.44	1.80*	2.10**	

Table 63. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Fort Meyers, Florida (II). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	343.0	200.0	98.0	129.0	103.5	Mean	349.6	239.2	349.4	296.0	ND
		SD						SD	35.6	34.5	49.6	10.2	
		ratio	NA	0.61	0.29	0.38	0.30	ratio	NA	0.68	1.00	0.85	
	-	Mean	220.0	151.5	167.5	144.0	183.5	Mean	302.8	279.4	297.0	338.2	
		SD						SD	6.4	64.1	55.7	17.2	
		ratio	NA	0.69	0.76	0.65	0.83	ratio	NA	0.92	0.98	1.11	
Finished water	+	Mean	343.0	122.0	111.0	129.0	88.5	Mean	349.6	262.2	282.4	348.4	4.7
		SD						SD	35.6	39.0	19.7	21.9	
		ratio	NA	0.36	0.32	0.38	0.26	ratio	NA	0.75	0.81	1.00	
	-	Mean	220.0	169.5	179.5	247.0	273.5	Mean	302.8	323.6	253.2	320.5	
		SD						SD	6.4	23.5	53.9	73.4	
		ratio	NA	0.77	0.82	1.12	1.24	ratio	NA	1.07	0.84	1.06	
Dist. I	+	Mean	343.0	213.5	153.0	214.0	149.0	Mean	349.6	256.0	317.4	354.6	6.4
		SD						SD	35.6	20.6	33.0	30.0	
		ratio	NA	0.62	0.45	0.62	0.43	ratio	NA	0.73	0.91	1.01	
	-	Mean	220.0	209.5	159.0	178.0	155.0	Mean	302.8	311.8	169.2	175.4	
		SD						SD	6.4	26.4	31.6	15.2	
		ratio	NA	0.95	0.72	0.81	0.70	ratio	NA	1.03	0.56	0.58	
Dist. II	+	Mean	343.0	190.0	211.5	162.0	168.5	Mean	349.6	341.6	366.6	256.2	2.0
		SD						SD	35.6	65.1	54.5	66.6	
		ratio	NA	0.55	0.62	0.47	0.49	ratio	NA	0.98	1.05	0.73	
	-	Mean	220.0	200.0	123.0	249.0	232.5	Mean	302.8	341.2	161.0	246.0	
		SD						SD	6.4	31.4	13.0	50.7	
		ratio	NA	0.91	0.56	1.13	1.06	ratio	NA	1.13	0.53	0.81	

Table 64. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Fort Meyers, Florida (II). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	52.5	49.5	64.5	69.5	52.0	Mean	173.6	123.4	155.2	203.0	ND
		SD						SD	16.5	11.4	8.6	25.0	
		ratio	NA	0.94	1.23	1.32	0.99	ratio	NA	0.70	0.89	1.17	
	-	Mean	61.5	60.5	52.5	69.5	77.5	Mean	158.4	142.4	110.8	242.0	
		SD						SD	17.1	7.2	11.4	25.3	
		ratio	NA	0.98	0.85	1.13	1.26	ratio	55.4	0.9	0.70	1.53*	
Finished water	+	Mean	52.5	43.5	43.5	30.5	39.0	Mean	173.6	157.8	253.0	264.8	4.7
		SD						SD	16.5	7.6	30.4	7.7	
		ratio	NA	0.83	0.83	0.58	0.74	ratio	NA	0.91	1.45	1.53*	
	-	Mean	61.5	59.0	49.5	27.0	33.5	Mean	158.4	138.0	218.0	246.6	
		SD						SD	17.1	16.4	33.9	18.1	
		ratio	NA	0.96	0.80	0.44	0.54	ratio	NA	0.87	1.38	1.56*	
Dist. I	+	Mean	52.5	60.5	65.0	65.0	80.5	Mean	173.6	103.0	219.6	176.0	6.4
		SD						SD	16.5	20.1	14.8	21.5	
		ratio	NA	1.15	1.24	1.24	1.53*	ratio	NA	0.59	1.26	1.01	
	-	Mean	61.5	48.0	45.0	45.0	31.0	Mean	158.4	106.0	190.4	264.2	
		SD						SD	17.1	20.8	21.5	44.7	
		ratio	NA	0.78	0.73	0.74	0.50	ratio	NA	0.67	1.20	1.67*	
Dist. II	+	Mean	52.5	55.5	54.5	42.5	49.0	Mean	173.6	69.8	95.0	169.0	2.0
		SD						SD	16.5	17.5	24.4	21.9	
		ratio	NA	1.06	1.04	0.81	0.93	ratio	NA	0.40	0.55	0.97	
	-	Mean	61.5	58.5	78.5	57.0	29.0	Mean	158.4	94.2	176.2	207.0	
		SD						SD	17.1	18.0	61.3	24.0	
		ratio	NA	0.95	1.28	0.93	0.47	ratio	NA	0.59	1.11	1.31	

Table 65. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Fort Meyers, Florida (II). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 ml	1/2	Full	PNA ng/l
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	49.8	41.2	36.0	27.0	ND
		ratio	NT	NT	NT	NT	NT	SD	7.3	3.1	7.4	4.0	
								ratio	NA	0.83	0.72	0.54	
	-	Mean	NT	NT	NT	NT	NT	Mean	53.6	54.2	47.8	17.0	
		ratio	NT	NT	NT	NT	NT	SD	5.1	7.6	3.6	2.9	
								ratio	NA	1.01	0.89	0.32	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	49.8	41.6	36.2	76.6	4.7
		ratio	NT	NT	NT	NT	NT	SD	7.3	22.5	7.6	6.8	
								ratio	NA	0.84	0.73	1.54*	
	-	Mean	NT	NT	NT	NT	NT	Mean	53.6	65.2	30.2	66.6	
		ratio	NT	NT	NT	NT	NT	SD	5.1	11.2	4.5	10.0	
								ratio	NA	1.22	0.56	1.24	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	49.8	33.0	32.2	49.8	6.4
		ratio	NT	NT	NT	NT	NT	SD	7.3	6.1	5.7	9.4	
								ratio	NA	0.66	0.65	1.00	
	-	Mean	NT	NT	NT	NT	NT	Mean	53.6	43.2	22.0	45.8	
		ratio	NT	NT	NT	NT	NT	SD	5.1	17.0	11.7	5.0	
								ratio	NA	0.81	0.41	0.85	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	49.8	43.4	68.8	44.2	2.0
		ratio	NT	NT	NT	NT	NT	SD	7.3	8.0	8.9	10.4	
								ratio	NA	0.87	1.38	0.89	
	-	Mean	NT	NT	NT	NT	NT	Mean	53.6	28.2	19.2	39.0	
		ratio	NT	NT	NT	NT	NT	SD	5.1	7.2	5.9	9.6	
								ratio	NA	0.53	0.36	0.73	

Table 66. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Fort Meyers, Florida (II). Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 ml	1/2	Full	PNA ng/l
Raw water	+	Mean	42.5	30.0	19.5	15.0	15.5	Mean	52.6	52.6	38.4	67.0	ND
		SD						SD	6.8	9.3	13.4	5.2	
		ratio	NA	0.71	0.46	0.35	0.36	ratio	NA	1.00	0.73	1.27	
	-	Mean	44.0	33.5	25.5	22.0	26.0	Mean	50.8	65.4	77.0	83.2	
		SD						SD	1.9	7.3	10.1	8.7	
		ratio	NA	0.76	0.58	0.50	0.59	ratio	NA	1.29	1.52*	1.64*	
Finished water	+	Mean	42.5	63.0	51.0	48.5	50.0	Mean	52.6	36.8	63.6	71.8	4.7
		SD						SD	6.8	6.9	8.3	3.6	
		ratio	NA	1.48	1.20	1.14	1.18	ratio	NA	0.70	1.21	1.37	
		Mean	44.0	54.0	49.5	53.0	45.0	Mean	50.8	54.6	67.4	72.6	
		SD						SD	1.9	10.0	4.4	7.0	
		ratio	NA	1.22	1.13	1.20	1.01	ratio	NA	1.07	1.33	1.43	
Dist. I	+	Mean	42.5	59.5	38.5	56.0	53.0	Mean	52.6	84.2	21.6	19.0	6.4
		SD						SD	6.8	5.4	3.4	1.6	
		ratio	NA	1.40	0.91	1.32	1.25	ratio	NA	1.60*	0.41	0.36	
	-	Mean	44.0	51.0	46.0	36.5	58.0	Mean	50.8	68.8	46.4	24.0	
		SD						SD	1.9	12.6	13.5	6.5	
		ratio	NA	1.16	1.05	0.83	1.32	ratio	NA	1.35	0.88	0.47	
Dist. II	+	Mean	42.5	61.5	64.5	47.5	49.0	Mean	52.6	39.2	45.0	33.4	2.0
		SD						SD	6.8	6.3	7.4	4.8	
		ratio	NA	1.45	1.52*	1.12	1.15	ratio	NA	0.74	0.86	0.63	
	-	Mean	44.0	61.0	42.5	27.5	33.0	Mean	50.8	27.4	69.2	35.2	
		SD						SD	1.9	4.6	11.3	12.6	
		ratio	NA	1.39	0.97	0.63	0.75	ratio	NA	0.54	1.36	0.69	

Table 67. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Fremont, Ohio. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	92.5	82.5	52.0	78.5	64.0	Mean	112.8	56.0	59.4	53.8	159
		SD						SD	25.7	32.3	30.6	18.3	
		ratio	NA	0.89	0.56	0.85	0.69	ratio	NA	0.50	0.53	0.48	
	-	Mean	90.0	86.0	84.5	46.0	26.5	Mean	84.8	34.2	45.2	44.2	
		SD						SD	33.7	11.0	5.8	5.8	
		ratio	NA	0.96	0.94	0.51	0.29	ratio	NA	0.40	0.53	0.52	
Finished water	+	Mean	92.5	83.5	48.5	53.0	51.0	Mean	112.8	70.6	85.6	73.4	2.4
		SD						SD	25.7	11.9	13.4	5.9	
		ratio	NA	0.90	0.52	0.57	0.55	ratio	NA	0.63	0.76	0.65	
	-	Mean	90.0	62.0	69.0	32.5	70.0	Mean	84.8	27.2	51.2	69.0	
		SD						SD	33.7	6.1	11.8	20.3	
		ratio	NA	0.69	0.77	0.36	0.78	ratio	5.74	0.32	0.60	0.81	
Dist. I	+	Mean	92.5	74.0	65.0	80.0	40.5	Mean	112.8	188.4	123.6	63.4	ND
		SD						SD	25.7	75.7	32.6	19.8	
		ratio	NA	0.80	0.70	0.86	0.43	ratio	NA	1.67*	1.10	0.56	
	-	Mean	90.0	70.5	56.0	55.5	25.5	Mean	84.8	67.2	70.0	34.8	
		SD						SD	33.7	27.2	24.9	2.8	
		ratio	NA	0.78	0.62	0.62	0.28	ratio	NA	0.79	0.83	0.41	
Dist. II	+	Mean	92.5	88.5	84.0	79.0	63.5	Mean	112.8	42.4	51.6	31.0	55.8
		SD						SD	25.7	13.0	9.6	11.0	
		ratio	NA	0.96	0.91	0.85	0.69	ratio	NA	0.38	0.46	0.28	
	-	Mean	90.0	66.5	66.0	108.5	128.0	Mean	84.8	35.4	30.4	30.6	
		SD						SD	33.7	6.8	5.1	6.6	
		ratio	NA	0.74	0.73	1.21	1.42	ratio	NA	0.42	0.36	0.36	

Table 68. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Fremont, Ohio. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA Present (Y/N)
Raw water	+	Mean	200.5	194.0	183.0	215.0	193.0	Mean	153.6	144.8	145.0	144.4	159
		SD						SD	18.7	13.1	10.6	16.1	
		ratio	NA	0.97	0.91	1.07	0.96	ratio	NA	0.94	0.94	0.94	
	-	Mean	204.5	249.0	350.5	256.5	317.5	Mean	134.0	108.0	116.0	125.2	
		SD						SD	7.7	5.9	7.4	5.5	
		ratio	NA	1.22	1.71*	1.25	1.53*	ratio	NA	0.81	0.87	0.93	
Finished water	+	Mean	200.5	139.5	149.5	156.0	142.5	Mean	153.6	163.6	163.8	138.8	2.4
		SD						SD	18.7	11.0	5.6	10.9	
		ratio	NA	0.70	0.75	0.78	0.71	ratio	NA	1.07	1.07	0.90	
	-	Mean	204.5	232.0	197.0	112.5	102.5	Mean	134.0	145.0	144.6	128.6	
		SD						SD	7.7	13.2	12.5	6.0	
		ratio	NA	1.13	0.96	0.55	0.51	ratio	NA	1.08	1.08	0.96	
Dist. I	+	Mean	200.5	178.0	218.0	138.5	220.0	Mean	153.6	158.4	156.2	170.2	ND
		SD						SD	18.7	4.4	5.9	8.7	
		ratio	NA	0.89	1.09	0.69	1.10	ratio	NA	1.03	1.02	1.11	
	-	Mean	204.5	212.0	236.0	197.5	180.5	Mean	134.0	110.2	111.4	160.2	
		SD						SD	7.7	10.7	16.2	6.8	
		ratio	NA	1.04	1.15	0.97	0.88	ratio	NA	0.82	0.83	1.20	
Dist. II	+	Mean	200.5	203.0	157.0	128.0	111.0	Mean	153.6	144.2	137.6	77.0	55.8
		SD						SD	18.7	20.6	17.0	11.1	
		ratio	NA	1.01	0.78	0.64	0.55	ratio	NA	0.94	0.90	0.50	
	-	Mean	204.5	229.0	142.5	248.0	160.5	Mean	134.0	123.2	117.0	95.6	
		SD						SD	7.7	23.9	11.2	12.5	
		ratio	NA	1.12	0.70	1.21	0.78	ratio	NA	0.92	0.87	0.71	

Table 69. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Fremont, Ohio. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	79.5	62.0	50.0	56.5	8.40	Mean	58.0	77.2	17.8	17.0	159
		ratio	NA	0.78	0.63	0.71	1.06	SD	8.6	17.7	4.1	2.1	
								ratio	NA	1.33	0.31	0.29	
	-	Mean	101.5	97.5	87.0	111.5	108.5	Mean	87.8	76.8	19.6	15.2	
		ratio	NA	0.96	0.86	1.10	1.07	SD	4.4	9.8	3.3	3.5	
								ratio	NA	0.88	0.22	0.17	
Finished water	+	Mean	79.5	60.5	54.5	86.5	82.0	Mean	58.0	74.2	35.6	20.6	2.4
		ratio	NA	0.76	0.69	1.09	1.03	SD	8.6	4.1	9.1	4.3	
								ratio	NA	1.28	0.61	0.36	
	-	Mean	101.5	107.0	106.5	75.6	84.5	Mean	87.8	62.8	43.6	36.0	
		ratio	NA	1.05	1.05	0.74	0.83	SD	4.4	7.5	8.3	7.0	
								ratio	NA	0.72	0.50	0.41	
Dist. I	+	Mean	79.5	67.5	52.5	69.5	85.5	Mean	58.0	62.0	33.0	18.0	ND
		ratio	NA	0.85	0.66	0.87	1.08	SD	8.6	26.7	8.1	4.1	
								ratio	NA	1.07	0.57	0.31	
	-	Mean	101.5	96.0	79.5	71.0	57.5	Mean	87.8	47.2	38.4	26.8	
		ratio	NA	0.95	0.78	0.70	0.57	SD	4.4	31.9	11.6	11.5	
								ratio	NA	0.54	0.40	0.31	
Dist. II	+	Mean	79.5	91.5	94.0	78.5	101.5	Mean	58.0	88.0	25.2	15.8	55.8
		ratio	NA	1.15	1.18	0.99	1.28	SD	8.6	12.8	9.6	4.0	
								ratio	NA	1.52*	0.43	0.27	
	-	Mean	101.5	88.5	98.5	113.0	110.5	Mean	87.8	68.0	27.0	26.0	
		ratio	NA	0.87	0.97	1.11	1.09	SD	4.4	8.3	12.0	2.5	
								ratio	NA	0.77	0.31	0.30	

Table 70. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Fremont, Ohio. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	33.4	17.8	20.6	17.6	159
		ratio	NT	NT	NT	NT	NT	SD	5.6	5.2	5.8	4.0	
								ratio	NA	0.53	0.62	0.53	
	-	Mean	NT	NT	NT	NT	NT	Mean	33.8	15.4	16.4	17.0	
		ratio	NT	NT	NT	NT	NT	SD	4.9	3.7	2.5	3.2	
								ratio	NA	0.46	0.99	0.50	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	33.4	16.2	22.6	24.2	2.4
		ratio	NT	NT	NT	NT	NT	SD	5.6	2.5	4.4	4.1	
								ratio	NA	0.49	0.68	0.73	
	-	Mean	NT	NT	NT	NT	NT	Mean	33.4	16.6	18.0	19.4	
		ratio	NT	NT	NT	NT	NT	SD	5.6	4.8	2.5	3.0	
								ratio	NA	0.49	0.53	0.57	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	33.4	24.6	17.0	17.2	ND
		ratio	NT	NT	NT	NT	NT	SD	5.6	3.9	4.9	4.9	
								ratio	NA	0.74	0.51	0.52	
	-	Mean	NT	NT	NT	NT	NT	Mean	33.4	17.4	16.4	15.4	
		ratio	NT	NT	NT	NT	NT	SD	5.6	3.9	2.4	5.5	
								ratio	NA	0.52	0.49	0.46	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	33.4	20.2	19.0	21.8	55.8
		ratio	NT	NT	NT	NT	NT	SD	5.6	2.7	4.9	2.6	
								ratio	NA	0.60	0.57	0.65	
	-	Mean	NT	NT	NT	NT	NT	Mean	33.4	15.2	16.8	15.6	
		ratio	NT	NT	NT	NT	NT	SD	5.6	3.8	1.5	1.5	
								ratio	NA	0.45	0.50	0.46	

Table 71. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Fremont, Ohio. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	53.0	70.0	68.5	92.5	101.0	Mean	13.4	4.2	13.6	7.6	159
		SD						SD	2.6	4.1	1.3	3.1	
		ratio	NA	1.32	1.29	1.75*	1.91*	ratio	NA	0.84	1.02	0.57	
	-	Mean	42.0	62.0	84.0	98.5	125.0	Mean	15.8	8.0	10.8	7.4	
		SD						SD	4.4	3.1	4.6	3.0	
		ratio	NA	1.48	2.0**	2.35**	2.40**	ratio	NA	0.51	0.68	0.47	
Finished water	+	Mean	56.0	63.5	48.5	68.5	52.0	Mean	13.4	13.0	6.6	5.8	2.4
		SD						SD	2.6	1.0	1.1	1.8	
		ratio	NA	1.20	0.92	1.29	0.98	ratio	NA	0.97	0.99	0.43	
		Mean	42.0	52.5	57.5	59.0	59.0	Mean	15.8	12.6	5.8	5.0	
		SD						SD	4.4	64.5	2.3	2.0	
		ratio	NA	1.25	1.37	1.40	1.40	ratio	NA	0.80	0.37	0.32	
Dist. I	+	Mean	56.0	60.0	68.0	48.0	63.5	Mean	13.4	18.0	7.8	10.2	ND
		SD						SD	2.6	4.4	3.4	3.3	
		ratio	NA	1.13	1.28	0.91	1.20	ratio	NA	1.34	0.58	0.76	
	-	Mean	42.0	78.5	55.0	56.0	65.5	Mean	15.8	12.8	6.8	5.0	
		SD						SD	4.4	4.6	3.6	2.0	
		ratio	NA	1.87*	1.31	1.33	0.56	ratio	NA	0.81	0.43	0.32	
Dist. II	+	Mean	56.0	61.5	41.0	55.0	47.5	Mean	13.4	14.6	9.0	8.8	55.8
		SD						SD	2.6	4.7	4.0	3.5	
		ratio	NA	1.16	0.77	1.31	0.90	ratio	NA	1.09	0.67	0.66	
	-	Mean	42.0	74.5	70.5	63.0	66.5	Mean	15.8	16.2	5.2	15.2	
		SD						SD	4.4	2.8	1.9	1.6	
		ratio	NA	1.77*	1.68*	1.50*	1.58*	ratio	NA	1.03	0.33	0.96	

Table 72. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Ft. Mitchell, Kentucky. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	68.5	61.0	68.5	64.0	65.5	Mean	63.4	88.4	65.0	78.4	10.8
		SD						SD	14.05	10.92	22.79	10.31	
		ratio	NA	0.89	1.00	0.93	0.96	ratio	NA	1.39	1.03	1.24	
	-	Mean	40.0	39.0	41.0	44.0	48.0	Mean	74.0	75.8	52.8	63.6	
		SD						SD	17.65	15.21	21.58	12.93	
		ratio	NA	0.98	1.03	1.1	1.20	ratio	NA	1.02	0.71	0.86	
Finished water	+	Mean	68.5	47.5	49.0	61.0	73.5	Mean	63.4	79.6	67.0	78.2	1.1
		SD						SD	14.05	4.16	20.44	13.48	
		ratio	NA	0.69	0.72	0.89	1.07	ratio	NA	1.26	1.06	1.23	
	-	Mean	40.0	53.0	36.5	41.5	46.5	Mean	74.0	57.0	61.4	69.0	
		SD						SD	17.65	16.06	18.78	4.64	
		ratio	NA	1.33	0.91	1.04	1.16	ratio	NA	0.77	0.82	0.93	
Dist. I	+	Mean	68.5	63.0	65.5	66.5	69.0	Mean	63.4	66.2	55.0	72.0	4.5
		SD						SD	14.05	18.46	10.27	25.12	
		ratio	NA	0.92	0.96	0.97	1.01	ratio	NA	1.04	0.86	1.14	
	-	Mean	40.0	44.0	47.0	51.5	48.5	Mean	74.0	53.2	44.8	45.2	
		SD						SD	17.65	12.45	20.09	16.60	
		ratio	NA	1.10	1.18	1.29	1.21	ratio	NA	0.72	0.61	0.61	
Dist. II	+	Mean	68.5	70.0	78.0	56.5	37.5	Mean	63.4	64.8	54.2	34.6	3.9
		SD						SD	14.05	11.37	8.35	7.70	
		ratio	NA	1.02	1.14	0.82	0.55	ratio	NA	1.02	0.85	0.55	
	-	Mean	40.0	49.5	41.0	37.5	54.0	Mean	74.0	42.2	62.8	35.2	
		SD						SD	17.65	12.07	21.22	6.42	
		ratio	NA	1.24	1.03	0.94	1.35	ratio	NA	0.57	0.85	0.48	

Table 73. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Ft. Mitchell, Kentucky. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	150.0	165.5	158.0	141.0	158.0	Mean	136.2	154.6	166.8	168.0	10.8
		SD						SD	14.62	15.09	18.46	5.96	
		ratio	NA	1.10	1.05	0.94	1.05	ratio	NA	1.14	1.22	1.23	
	-	Mean	166.0	147.5	129.0	139.5	132.5	Mean	128.4	129.2	144.0	144.8	
		SD						SD	16.30	14.16	16.42	22.26	
		ratio	NA	0.89	0.78	0.84	0.80	ratio	NA	1.01	1.12	1.13	
Finished water	+	Mean	150.0	149.5	128.0	142.5	141.5	Mean	136.2	151.6	175.4	158.8	1.1
		SD						SD	14.62	4.39	8.53	9.01	
		ratio	NA	1.00	0.85	0.95	0.94	ratio	NA	1.11	1.29	1.17	
	-	Mean	166.0	126.5	141.0	129.5	130.5	Mean	128.4	136.8	157.8	153.4	
		SD						SD	16.30	12.52	10.57	24.50	
		ratio	NA	0.76	0.85	0.78	0.79	ratio	NA	1.07	1.23	1.19	
Dist. I	+	Mean	150.0	135.5	126.0	151.5	154.0	Mean	136.2	126.6	172.4	152.2	4.5
		SD						SD	14.62	7.50	17.77	16.59	
		ratio	NA	0.90	0.84	1.01	1.03	ratio	NA	0.93	1.27	1.12	
	-	Mean	166.0	140.5	140.5	124.0	138.0	Mean	128.4	115.2	159.2	148.6	
		SD						SD	16.30	18.77	18.05	22.63	
		ratio	NA	0.85	0.85	0.75	0.83	ratio	NA	0.90	1.24	1.16	
Dist. II	+	Mean	150.0	147.5	137.0	171.0	127.5	Mean	136.2	127.4	126.6	146.4	3.9
		SD						SD	14.62	21.22	9.58	17.02	
		ratio	NA	0.98	0.91	1.14	0.85	ratio	NA	0.94	0.93	1.07	
	-	Mean	166.0	164.5	152.5	101.5	115.5	Mean	128.4	119.2	146.4	160.0	
		SD						SD	16.30	18.71	26.62	11.70	
		ratio	NA	0.99	0.92	0.61	0.70	ratio	NA	0.93	1.14	1.25	

Table 74. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Ft. Mitchell, Kentucky. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	80.0	91.5	102.5	94.0	107.0	Mean	49.0	67.6	84.8	87.2	10.8
		SD						SD	9.46	4.16	8.70	4.97	
		ratio	NA	1.14	1.28	1.18	1.34	ratio	NA	1.38	1.73*	1.78*	
	-	Mean	99.0	88.5	90.5	75.0	100.0	Mean	79.0	63.4	71.4	72.4	
		SD						SD	16.83	6.54	19.88	18.65	
		ratio	NA	0.89	0.91	0.76	1.01	ratio	NA	0.80	0.93	0.92	
Finished water	+	Mean	80.0	102.5	102.5	84.0	92.5	Mean	49.0	77.0	48.4	39.4	1.1
		SD						SD	9.46	9.40	5.32	3.44	
		ratio	NA	1.28	1.28	1.05	1.16	ratio	NA	1.57*	0.99	0.80	
	-	Mean	99.0	91.0	85.5	78.5	82.0	Mean	79.0	60.8	89.4	41.0	
		SD						SD	16.83	5.11	3.97	6.44	
		ratio	NA	0.92	0.86	0.79	0.83	ratio	NA	0.77	1.13	0.51	
Dist. I	+	Mean	80.0	95.5	97.0	67.5	80.0	Mean	49.0	84.8	110.2	30.2	4.5
		SD						SD	9.46	8.61	18.99	15.90	
		ratio	NA	1.19	1.21	0.84	1.00	ratio	NA	1.73*	2.25**	0.62	
	-	Mean	99.0	86.0	90.0	122.0	94.5	Mean	79.0	116.2	88.6	44.4	
		SD						SD	16.83	22.26	7.89	11.26	
		ratio	NA	0.87	0.91	1.23	0.95	ratio	NA	1.47	1.12	0.56	
Dist. II	+	Mean	80.0	74.5	69.0	88.0	90.5	Mean	49.0	56.0	78.0	28.2	3.9
		SD						SD	9.46	12.19	12.06	4.76	
		ratio	NA	0.93	0.86	1.10	1.13	ratio	NA	1.14	1.59*	0.58	
	-	Mean	99.0	86.5	77.0	93.0	80.0	Mean	79.0	58.0	87.6	30.6	
		SD						SD	16.83	11.73	14.47	8.65	
		ratio	NA	0.87	0.78	0.94	0.87	ratio	NA	0.73	1.11	0.39	

Table 75. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Ft. Mitchell, Kentucky. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	74.8	51.4	44.4	31.2	10.8
		ratio	NT	NT	NT	NT	NT	SD	10.85	9.86	8.20	5.50	
								ratio	NA	0.69	0.59	0.42	
	-	Mean	NT	NT	NT	NT	NT	Mean	59.4	30.0	47.2	26.4	
		ratio	NT	NT	NT	NT	NT	SD	17.52	5.79	14.15	6.95	
								ratio	NA	0.51	0.79	0.44	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	74.8	52.0	49.8	40.6	1.1
		ratio	NT	NT	NT	NT	NT	SD	10.85	10.54	14.38	7.60	
								ratio	NA	0.70	0.67	0.65	
	-	Mean	NT	NT	NT	NT	NT	Mean	59.4	51.4	33.8	35.0	
		ratio	NT	NT	NT	NT	NT	SD	17.52	11.72	8.23	6.20	
								ratio	NA	0.87	0.57	0.59	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	74.8	63.4	51.0	38.8	4.5
		ratio	NT	NT	NT	NT	NT	SD	10.85	15.47	15.39	9.98	
								ratio	NA	0.85	0.68	0.52	
	-	Mean	NT	NT	NT	NT	NT	Mean	59.4	59.6	36.6	29.0	
		ratio	NT	NT	NT	NT	NT	SD	17.52	7.16	8.44	13.73	
								ratio	NA	1.00	0.61	0.49	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	74.8	37.8	43.0	69.0	3.9
		ratio	NT	NT	NT	NT	NT	SD	10.85	7.66	5.96	3.00	
								ratio	NA	0.51	0.57	0.92	
	-	Mean	NT	NT	NT	NT	NT	Mean	59.4	36.0	55.8	52.6	
		ratio	NT	NT	NT	NT	NT	SD	17.52	12.65	23.15	9.79	
								ratio	NA	0.61	0.94	0.89	

Table 76. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Ft. Mitchell, Kentucky. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 ml	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	47.5	40.5	32.0	38.5	36.5	Mean	43.6	46.2	52.6	45.4	10.8
		SD						SD	5.56	5.59	26.77	6.94	
		ratio	NA	0.85	0.67	0.81	0.77	ratio	NA	1.06	1.20	1.04	
	-	Mean	28.5	25.5	23.5	24.0	22.0	Mean	28.8	35.0	23.6	19.6	
		SD						SD	4.76	6.44	7.09	5.13	
		ratio	NA	0.89	0.82	0.84	0.77	ratio	NA	1.22	0.82	0.68	
Finished water	+	Mean	47.5	36.5	42.5	48.5	50.5	Mean	43.6	38.0	50.4	36.6	1.1
		SD						SD	5.56	8.19	6.15	8.47	
		ratio	NA	0.77	0.89	1.02	1.06	ratio	NA	0.87	1.16	0.84	
	-	Mean	28.5	32.0	29.0	20.5	29.0	Mean	28.8	32.8	26.4	16.0	
		SD						SD	4.76	6.14	4.72	5.24	
		ratio	NA	1.12	1.02	0.72	1.02	ratio	NA	1.14	0.92	0.56	
Dist. I	+	Mean	47.5	43.5	36.5	36.5	42.0	Mean	43.6	66.4	54.0	45.0	4.5
		SD						SD	5.56	19.94	10.86	10.56	
		ratio	NA	0.92	0.77	0.77	0.88	ratio	NA	1.52*	1.24	1.03	
	-	Mean	28.5	29.0	27.5	24.0	32.0	Mean	28.8	53.4	30.0	29.2	
		SD						SD	4.76	11.15	10.98	7.26	
		ratio	NA	1.02	0.96	0.84	1.12	ratio	NA	1.85*	1.04	1.01	
Dist. II	+	Mean	47.5	44.0	39.5	22.5	34.5	Mean	43.6	38.5	49.0	34.4	3.9
		SD						SD	5.56	19.60	7.58	10.88	
		ratio	NA	0.93	0.83	0.47	0.73	ratio	NA	0.89	1.12	0.79	
	-	Mean	28.5	32.5	28.5	28.0	26.5	Mean	28.8	32.8	15.6	19.8	
		SD						SD	4.76	4.02	5.50	2.68	
		ratio	NA	1.14	1.00	0.98	0.93	ratio	NA	1.14	0.54	0.69	

Table 77. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Hutchinson, Kansas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	91.5	83.0	77.5	83.5	88.0	Mean	119.2	93.4	82.2	79.0	ND
		SD						SD	11.67	24.98	8.56	11.98	
		ratio	NA	0.91	0.85	0.91	0.96	ratio	NA	0.78	0.69	0.66	
	-	Mean	100.5	96.0	105.0	114.5	109.0	Mean	88.89	69.6	66.2	67.4	
		SD						SD	18.14	9.04	8.81	9.58	
		ratio	NA	0.96	1.04	1.14	1.08	ratio	NA	0.78	0.74	0.76	
Finished water	+	Mean	91.5	93.5	92.0	89.5	103.0	Mean	119.2	119.0	96.4	77.8	3.3
		SD						SD	11.67	8.83	5.90	2.68	
		ratio	NA	1.02	1.01	0.98	1.12	ratio	NA	0.99	0.80	0.65	
	-	Mean	100.5	106.5	105.0	97.0	98.5	Mean	88.8	88.6	76.0	70.4	
		SD						SD	18.14	28.23	9.75	8.32	
		ratio	NA	1.06	1.04	0.97	0.98	ratio	NA	0.99	0.85	0.79	
Dist. I	+	Mean	91.5	75.5	88.0	92.5	95.0	Mean	119.2	121.0	77.0	84.6	1.8
		SD						SD	11.67	8.28	9.17	13.50	
		ratio	NA	0.83	0.96	1.01	1.04	ratio	NA	1.02	0.64	0.70	
	-	Mean	100.5	103.0	98.0	106.0	108.0	Mean	88.8	79.4	65.8	67.8	
		SD						SD	18.14	5.18	9.88	8.79	
		ratio	NA	1.02	0.98	1.05	1.07	ratio	NA	0.89	0.74	0.76	
Dist. II	+	Mean	91.5	112.5	98.5	102.5	111.0	Mean	119.2	129.0	96.6	78.4	1.9
		SD						SD	11.67	13.84	9.69	11.72	
		ratio	NA	1.23	1.08	1.12	1.21	ratio	NA	1.08	0.81	0.66	
	-	Mean	100.5	105.0	114.5	111.5	133.0	Mean	88.8	78.2	74.6	67.0	
		SD						SD	18.14	6.69	5.86	11.14	
		ratio	NA	1.04	1.14	1.11	1.32	ratio	NA	0.88	0.84	0.75	

Table 78. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Hutchinson, Kansas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	282.0	327.5	265.0	272.5	273.0	Mean	311.8	265.6	256.2	244.2	ND
		SD						SD	27.31	9.84	26.09	30.43	
		ratio	NA	1.16	0.93	0.97	0.87	ratio	NA	0.84	0.82	0.78	
	-	Mean	315.0	306.0	328.0	329.0	341.5	Mean	343.4	253.4	212.4	197.8	
		SD						SD	25.75	43.90	25.35	26.39	
		ratio	NA	0.97	1.04	1.04	1.08	ratio	NA	0.74	0.61	0.57	
Finished water	+	Mean	282.0	298.0	313.5	290.0	321.5	Mean	311.8	295.6	306.4	280.0	3.3
		SD						SD	27.31	13.07	16.70	22.53	
		ratio	NA	1.06	1.11	1.02	1.14	ratio	NA	0.94	0.98	0.89	
	-	Mean	315.0	332.5	337.5	349.5	394.0	Mean	343.4	348.0	287.0	238.2	
		SD						SD	25.75	17.33	18.80	21.24	
		ratio	NA	1.06	1.07	1.11	1.25	ratio	NA	1.01	0.83	0.69	
Dist. I	+	Mean	282.0	277.5	252.5	281.5	277.5	Mean	311.8	306.2	299.2	291.0	1.8
		SD						SD	27.31	11.05	19.75	5.66	
		ratio	NA	0.98	0.90	1.00	0.98	ratio	NA	0.98	0.95	0.93	
	-	Mean	315.0	287.5	304.5	271.0	317.5	Mean	343.4	343.4	254.0	256.2	
		SD						SD	25.75	16.01	29.13	57.77	
		ratio	NA	0.91	0.97	0.86	1.01	ratio	NA	1.00	0.74	0.74	
Dist. II	+	Mean	282.0	300.0	294.0	310.0	286.0	Mean	311.8	296.8	308.6	318.8	1.9
		SD						SD	27.31	20.14	20.08	21.14	
		ratio	NA	1.06	1.04	1.10	1.01	ratio	NA	0.95	0.98	1.02	
	-	Mean	315.0	355.5	390.5	328.0	310.5	Mean	343.4	373.2	290.0	264.4	
		SD						SD	25.75	16.93	21.06	10.24	
		ratio	NA	1.13	1.24	1.04	0.99	ratio	NA	1.94*	0.84	0.77	

Table 79. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Hutchinson, Kansas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	69.0	73.5	52.0	49.5	51.5	Mean	80.0	86.0	115.0	116.0	ND
		ratio	NA	1.07	0.75	0.72	0.75	SD	17.39	14.73	9.77	17.72	
								ratio	NA	1.07	1.44	1.45	
	-	Mean	75.0	81.5	63.5	80.5	56.0	Mean	87.2	74.6	110.4	106.4	
		ratio	NA	1.09	0.85	1.07	0.75	SD	10.83	11.97	4.16	13.18	
								ratio	NA	0.86	1.26	1.22	
Finished water	+	Mean	69.0	62.5	76.5	52.5	44.0	Mean	80.0	58.8	101.8	100.0	3.3
		ratio	NA	0.91	1.11	0.76	0.64	SD	17.39	10.13	9.88	11.11	
								ratio	NA	0.74	1.27	1.25	
	-	Mean	75.0	86.0	78.0	62.5	77.5	Mean	87.2	83.2	109.4	110.2	
		ratio	NA	1.15	1.04	0.83	1.03	SD	10.83	19.31	15.84	17.58	
								ratio	NA	0.95	1.25	1.26	
Dist. I	+	Mean	69.0	45.5	61.5	53.5	41.0	Mean	80.0	61.0	80.4	92.4	1.8
		ratio	NA	0.66	0.89	0.77	0.59	SD	17.39	10.56	12.14	19.42	
								ratio	NA	0.76	1.00	1.15	
	-	Mean	75.0	91.0	69.0	68.0	62.0	Mean	87.2	98.6	85.2	99.2	
		ratio	NA	1.21	0.92	0.91	0.83	SD	10.83	8.44	8.70	5.93	
								ratio	NA	1.13	0.97	1.14	
Dist. II	+	Mean	69.0	60.0	55.0	41.5	51.5	Mean	80.0	58.2	95.6	97.4	1.9
		ratio	NA	0.87	0.80	0.60	0.75	SD	17.39	7.36	11.22	10.55	
								ratio	NA	0.72	1.19	1.22	
	-	Mean	75.0	72.0	62.5	59.5	66.0	Mean	87.2	75.8	100.6	99.2	
		ratio	NA	0.96	0.83	0.79	0.88	SD	10.83	4.09	12.86	9.81	
								ratio	NA	0.86	1.15	1.13	

Table 80. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Hutchinson, Kansas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	28.8	19.4	17.2	20.8	ND
		ratio	NT	NT	NT	NT	NT	SD	2.0	4.72	3.19	4.15	
								ratio	NA	0.69	0.61	0.74	
	-	Mean	NT	NT	NT	NT	NT	Mean	13.4	14.8	14.4	8.8	
		ratio	NT	NT	NT	NT	NT	SD	4.28	3.42	2.51	3.49	
								ratio	NA	0.51	1.07	0.66	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	28.8	21.6	21.4	17.6	3.3
		ratio	NT	NT	NT	NT	NT	SD	2.0	9.71	4.93	0.89	
								ratio	NA	0.77	0.76	0.62	
	-	Mean	NT	NT	NT	NT	NT	Mean	13.4	14.6	11.8	13.2	
		ratio	NT	NT	NT	NT	NT	SD	4.28	4.16	8.3	3.11	
								ratio	NA	1.09	0.88	0.98	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	28.8	27.2	17.4	14.4	1.8
		ratio	NT	NT	NT	NT	NT	SD	2.0	1.92	6.11	4.04	
								ratio	NA	0.97	0.62	0.51	
	-	Mean	NT	NT	NT	NT	NT	Mean	13.4	21.8	14.2	15.6	
		ratio	NT	NT	NT	NT	NT	SD	4.28	5.85	4.09	5.55	
								ratio	NA	1.61*	1.06	1.16	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	28.8	28.0	19.6	13.8	1.9
		ratio	NT	NT	NT	NT	NT	SD	2.0	2.74	6.88	4.87	
								ratio	NA	1.00	0.70	0.49	
	-	Mean	NT	NT	NT	NT	NT	Mean	13.4	16.4	13.6	14.2	
		ratio	NT	NT	NT	NT	NT	SD	4.28	2.70	2.97	4.97	
								ratio	NA	1.22	1.01	1.06	

Table 81. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Hutchinson, Kansas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	28.0	28.5	28.0	33.0	52.5	Mean	33.0	30.2	27.8	25.0	ND
		SD						SD	8.51	7.60	8.35	5.70	
		ratio	NA	1.02	1.00	1.18	1.80*	ratio	NA	0.91	0.84	0.75	
	-	Mean	24.0	17.0	29.0	29.5	33.5	Mean	24.8	19.6	22.0	18.4	
		SD						SD	6.91	3.97	3.46	3.91	
		ratio	NA	0.71	1.21	1.23	1.40	ratio	NA	0.79	0.88	0.74	
Finished water	+	Mean	28.0	19.0	29.0	25.0	32.5	Mean	33.0	29.4	31.8	23.8	3.3
		SD						SD	8.51	7.57	3.56	9.28	
		ratio	NA	0.68	1.04	0.89	1.16	ratio	NA	0.84	0.96	0.72	
	-	Mean	24.0	28.0	26.5	24.0	13.5	Mean	24.8	21.6	22.2	17.8	
		SD						SD	6.91	3.78	3.56	1.92	
		ratio	NA	1.17	1.10	1.00	0.56	ratio	NA	0.87	0.89	0.71	
Dist. I	+	Mean	28.0	22.5	17.0	25.0	28.0	Mean	33.0	32.2	29.2	22.6	1.8
		SD						SD	8.51	6.46	11.17	7.13	
		ratio	NA	0.80	0.61	0.89	1.00	ratio	NA	0.98	0.88	0.68	
	-	Mean	24.0	27.0	24.0	24.0	20.0	Mean	24.8	27.0	18.4	17.2	
		SD						SD	6.91	4.18	2.97	6.30	
		ratio	NA	1.13	1.00	1.00	0.83	ratio	NA	1.08	0.74	0.69	
Dist. II	+	Mean	28.0	38.0	29.0	24.5	30.5	Mean	33.0	29.0	24.2	19.6	1.9
		SD						SD	8.51	7.0	8.53	6.69	
		ratio	NA	1.36	1.04	0.88	1.09	ratio	NA	1.26	0.73	0.54	
	-	Mean	24.0	26.5	24.0	24.5	26.5	Mean	24.8	31.4	16.6	13.4	
		SD						SD	6.91	2.79	2.7	4.51	
		ratio	NA	1.10	1.00	1.02	1.10	ratio	NA	0.88	0.66	0.54	

Table 82. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Iowa City, Iowa. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	63.5	55.5	58.5	NT	69.5	Mean	57.0	52.2	57.2	53.6	8.3
		SD						SD	8.8	5.5	8.3	5.9	
		ratio	NA	0.87	0.92	NT	1.09	ratio	NA	0.92	1.00	0.94	
	-	Mean	83.5	44.5	53.0	NT	67.5	Mean	45.8	50.4	47.8	52.4	
		SD						SD	5.4	8.3	9.9	9.0	
		ratio	NA	0.53	0.63	NT	0.81	ratio	NA	1.10	1.04	1.14	
Finished water	+	Mean	63.5	70.5	59.0	NT	84.0	Mean	57.0	53.8	64.2	53.4	ND
		SD						SD	8.8	11.0	5.2	7.2	
		ratio	NA	1.11	0.93	NT	1.32	ratio	NA	0.94	1.13	0.94	
	-	Mean	83.5	79.5	71.5	NT	83.5	Mean	45.8	51.8	53.2	51.4	
		SD						SD	5.4	1.1	2.8	7.1	
		ratio	NA	0.95	0.86	NT	1.00	ratio	NA	1.13	1.16	1.12	
Dist. I	+	Mean	63.5	63.5	62.0	NT	69.5	Mean	57.0	49.8	62.2	56.8	1.0
		SD						SD	8.8	5.1	11.2	4.4	
		ratio	NA	1.00	0.98	NT	1.09	ratio	NA	0.87	1.09	1.00	
	-	Mean	83.5	93.0	69.0	NT	97.0	Mean	45.8	48.6	50.4	57.6	
		SD						SD	5.4	7.2	8.0	5.1	
		ratio	NA	1.11	0.83	NT	1.16	ratio	NA	1.06	1.10	1.26	
Dist. II	+	Mean	63.5	71.5	61.5	NT	70.0	Mean	57.0	53.6	57.6	56.2	2.0
		SD						SD	8.8	8.1	8.2	8.7	
		ratio	NA	1.13	0.97	NT	1.10	ratio	NA	0.94	1.01	0.99	
	-	Mean	83.5	67.0	93.0	NT	80.0	Mean	45.8	47.0	46.0	55.2	
		SD						SD	5.4	9.5	7.5	5.1	
		ratio	NA	0.80	1.11	NT	0.96	ratio	NA	1.03	1.00	1.21	

Table 83. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Iowa City, Iowa. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	235.0	261.0	278.5	NT	267.0	Mean	503.2	437.6	488.2	437.8	8.3
		SD						SD	37.5	115.9	51.7	24.5	
		ratio	NA	1.11	1.19	NT	1.14	ratio	NA	0.87	0.97	0.87	
	-	Mean	301.0	325.5	320.5	NT	361.0	Mean	382.2	413.8	330.4	354.8	
		SD						SD	91.3	33.0	16.4	18.8	
		ratio	NA	1.08	1.06	NT	1.20	ratio	NA	1.08	0.87	0.93	
Finished water	+	Mean	235.0	248.5	227.0	NT	265.0	Mean	503.2	491.0	383.8	391.2	ND
		SD						SD	37.5	30.4	30.7	21.5	
		ratio	NA	1.06	0.97	NT	1.13	ratio	NA	0.98	0.76	0.78	
	-	Mean	301.0	337.0	345.0	NT	403.0	Mean	382.2	422.2	337.6	349.8	
		SD						SD	91.3	54.6	15.2	17.5	
		ratio	NA	1.12	1.15	NT	1.34	ratio	NA	1.11	0.88	0.92	
Dist. I	+	Mean	235.0	284.0	231.5	NT	268.0	Mean	503.2	441.4	364.2	388.8	1.0
		SD						SD	37.5	35.4	31.4	12.5	
		ratio	NA	1.21	0.99	NT	1.14	ratio	NA	0.88	0.72	0.77	
	-	Mean	301.0	317.5	303.0	NT	398.0	Mean	382.2	361.2	399.6	385.2	
		SD						SD	91.3	22.6	29.1	22.7	
		ratio	NA	1.05	1.01	NT	1.32	ratio	NA	0.95	1.05	1.01	
Dist. II	+	Mean	235.0	273.0	284.0	NT	279.0	Mean	503.2	376.6	456.0	489.4	2.0
		SD						SD	37.5	124.1	25.6	17.2	
		ratio	NA	1.16	1.21	NT	1.19	ratio	NA	0.75	0.91	0.97	
	-	Mean	301.0	313.0	310.0	NT	359.5	Mean	382.2	405.4	379.4	420.6	
		SD						SD	91.3	37.6	14.7	28.0	
		ratio	NA	1.04	1.03	NT	1.19	ratio	NA	1.06	0.99	1.10	

Table 84. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Iowa City, Iowa. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	36.0	46.5	30.0	NT	57.5	Mean	186.6	271.2	165.2	148.4	8.3
		SD						SD	12.1	30.7	12.4	15.8	
		ratio	NA	1.29	0.83	NT	1.59*	ratio	NA	1.45	0.89	0.80	
	-	Mean	75.0	99.0	75.5	NT	101.0	Mean	186.8	169.0	141.8	126.8	
		SD						SD	11.1	15.6	11.3	21.9	
		ratio	NA	1.32	1.01	NT	1.34	ratio	NA	0.91	0.76	0.68	
Finished water	+	Mean	36.0	39.0	57.5	NT	44.0	Mean	186.6	200.8	171.6	4.0	ND
		SD						SD	12.1	29.0	15.0	3.2	
		ratio	NA	1.08	1.60*	NT	1.22	ratio	NA	1.08	0.92	0.02	
	-	Mean	75.0	84.0	116.0	NT	110.5	Mean	186.8	175.8	141.2	4.0	
		SD						SD	11.1	47.5	6.5	2.6	
		ratio	NA	1.12	1.55*	NT	1.47	ratio	NA	0.94	0.76	0.02	
Dist. I	+	Mean	36.0	56.5	35.5	NT	42.0	Mean	186.6	174.0	196.8	155.2	1.0
		SD						SD	12.1	37.9	25.6	16.7	
		ratio	NA	1.56*	0.99	NT	1.17	ratio	NA	0.93	1.06	0.83	
	-	Mean	75.0	90.5	105.0	NT	102.5	Mean	186.8	136.8	161.2	146.2	
		SD						SD	11.1	24.9	34.5	16.8	
		ratio	NA	1.21	1.40	NT	1.37	ratio	NA	0.73	0.86	0.78	
Dist. II	+	Mean	36.0	48.5	60.5	NT	44.5	Mean	186.6	170.0	202.6	176.4	2.0
		SD						SD	12.1	21.3	16.2	21.1	
		ratio	NA	1.34	1.68*	NT	1.24	ratio	NA	0.91	1.09	0.95	
	-	Mean	75.0	102.5	113.0	NT	103.0	Mean	186.8	134.1	147.2	155.4	
		SD						SD	11.1	21.3	34.7	10.4	
		ratio	NA	1.37	1.51*	NT	1.37	ratio	NA	0.72	0.79	0.83	

Table 85. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Iowa City, Iowa. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	29.4	20.4	19.2	13.2	8.3
		ratio	NT	NT	NT	NT	NT	SD	9.5	4.3	3.5	5.0	
								ratio	NA	0.69	0.65	0.45	
	-	Mean	NT	NT	NT	NT	NT	Mean	25.4	9.4	9.6	8.8	
		ratio	NT	NT	NT	NT	NT	SD	4.3	5.0	3.2	3.1	
								ratio	NA	0.37	0.38	0.35	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	29.4	40.2	30.6	29.8	ND
		ratio	NT	NT	NT	NT	NT	SD	9.5	11.8	7.5	4.2	
								ratio	NA	1.37	1.04	1.01	
	-	Mean	NT	NT	NT	NT	NT	Mean	25.4	41.6	22.2	18.2	
		ratio	NT	NT	NT	NT	NT	SD	4.3	11.7	5.5	7.0	
								ratio	NA	1.64*	0.76	0.72	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	29.4	41.2	27.4	22.6	1.0
		ratio	NT	NT	NT	NT	NT	SD	9.5	4.2	6.3	6.7	
								ratio	NA	1.40	0.93	0.77	
	-	Mean	NT	NT	NT	NT	NT	Mean	25.4	34.0	20.4	17.6	
		ratio	NT	NT	NT	NT	NT	SD	4.3	8.8	4.2	5.5	
								ratio	NA	1.34	0.80	0.69	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	29.4	36.2	29.8	27.2	2.0
		ratio	NT	NT	NT	NT	NT	SD	9.5	2.5	2.6	6.6	
								ratio	NA	1.23	1.01	0.93	
	-	Mean	NT	NT	NT	NT	NT	Mean	25.4	36.2	21.2	14.4	
		ratio	NT	NT	NT	NT	NT	SD	4.3	10.1	9.3	3.8	
								ratio	NA	1.43	0.84	0.57	

Table 86. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Iowa City, Iowa. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	39.0	23.0	24.0	NT	22.0	Mean	27.0	25.6	21.2	22.6	8.3
		ratio	NA	0.59	0.61	NT	0.56	SD	10.2	4.8	3.5	6.4	
								ratio	NA	0.95	0.79	0.84	
	-	Mean	17.5	23.0	15.5	NT	18.0	Mean	18.2	19.6	14.8	18.2	
		ratio	NA	1.31	0.89	NT	1.03	SD	4.1	4.0	1.6	3.9	
								ratio	NA	1.08	0.81	1.00	
Finished water	+	Mean	39.0	31.5	24.0	NT	19.5	Mean	27.0	32.8	18.8	18.2	ND
		ratio	NA	0.81	0.61	NT	0.5	SD	10.2	6.1	4.2	6.2	
								ratio	NA	1.22	0.70	0.67	
		Mean	17.5	24.5	22.5	NT	14.5	Mean	18.2	22.4	16.8	10.4	
		ratio	NA	1.40	1.29	NT	0.82	SD	4.1	4.6	3.1	3.9	
								ratio	NA	1.23	0.92	0.57	
Dist. I	+	Mean	39.0	36.5	32.5	NT	35.0	Mean	27.0	28.0	19.4	20.4	1.0
		ratio	NA	0.94	0.83	NT	0.90	SD	10.2	2.0	4.2	0.55	
								ratio	NA	1.04	0.72	0.76	
	-	Mean	17.5	25.0	25.5	NT	42.5	Mean	18.2	21.0	19.4	17.0	
		ratio	NA	1.42	1.46	NT	2.42**	SD	4.1	3.5	3.8	2.7	
								ratio	NA	1.15	1.07	0.93	
Dist. II	+	Mean	39.0	29.5	24.5	NT	25.5	Mean	27.0	25.0	20.8	22.2	2.0
		ratio	NA	0.76	0.63	NT	0.65	SD	10.2	5.1	4.2	6.1	
								ratio	NA	0.93	0.77	0.82	
	-	Mean	17.5	20.5	21.5	NT	34.0	Mean	18.2	4.9	18.0	16.8	
		ratio	NA	1.17	1.23	NT	1.94*	SD	4.1	1.2	5.1	6.3	
								ratio	NA	1.18	0.99	0.92	

Table 87. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of La Crosse, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay, Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay, Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	63.0	60.5	57.5	NT	62.0	Mean	38.4	34.8	41.8	38.8	5.6
		ratio	NA	1.14	1.08	NT	1.17	SD	8.32	13.37	4.66	5.22	
								ratio	NA	0.91	1.09	1.01	
	-	Mean	53.0	51.0	44.5	NT	61.5	Mean	30.4	28.6	34.6	41.0	
		ratio	NA	0.96	0.84	NT	1.16	SD	7.02	8.64	3.78	12.96	
								ratio	NA	0.94	1.14	1.35	
Finished water	+	Mean	63.0	50.0	58.0	NT	72.5	Mean	38.4	34.6	31.8	41.8	4.0
		ratio	NA	0.94	1.09	NT	1.37	SD	8.32	6.27	3.03	6.06	
								ratio	1.68	0.90	0.83	1.09	
	-	Mean	53.0	56.0	49.0	NT	61.5	Mean	30.4	28.4	20.0	36.6	
		ratio	NA	1.06	0.92	NT	1.16	SD	7.02	10.11	4.3	12.44	
								ratio	5.74	0.93	0.66	1.20	
Dist. I	+	Mean	63.0	62.5	53.5	NT	58.5	Mean	38.4	30.8	43.0	40.6	5.4
		ratio	NA	1.18	1.01	NT	1.10	SD	8.32	8.50	11.53	13.09	
								ratio	NA	0.80	1.12	1.06	
	-	Mean	53.0	51.0	55.0	NT	51.5	Mean	30.4	29.6	32.6	34.0	
		ratio	NA	0.96	1.04	NT	0.97	SD	7.02	6.66	4.28	5.48	
								ratio	NA	0.97	1.07	1.12	
Dist. II	+	Mean	63.0	55.0	56.0	NT	53.5	Mean	38.4	38.0	43.8	43.0	2.1
		ratio	NA	1.04	1.06	NT	1.01	SD	8.32	5.83	5.54	7.35	
								ratio	NA	1.00	1.14	1.12	
	-	Mean	53.0	47.5	44.5	NT	46.5	Mean	30.4	22.4	3.08	37.4	
		ratio	NA	0.90	0.84	NT	0.88	SD	7.02	5.41	4.44	6.31	
								ratio	NA	0.74	1.01	1.23	

Table 88. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of La Crosse, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	278.5	281.0	225.0	NT	279.5	Mean	205.0	206.8	195.8	188.2	5.6
		SD				NT		SD	15.1	16.75	20.0	8.2	
		ratio	NA	1.01	0.81		1.00	ratio	NA	1.01	0.97	6.92	
	-	Mean	336.0	329.5	268.5	NT	282.0	Mean	159.4	190.8	189.6	200.2	
		SD				NT		SD	13.4	10.3	18.6	20.2	
		ratio	NA	0.98	0.80		0.84	ratio	NA	1.20	1.19	1.26	
Finished water	+	Mean	278.5	313.0	241.5	NT	200.5	Mean	205.0	205.6	209.2	201.6	4.0
		SD				NT		SD	15.1	23.9	15.5	8.82	
		ratio	NA	1.12	0.87		0.72	ratio	NA	1.00	1.02	0.98	
	-	Mean	336.0	282.0	260.0	NT	266.5	Mean	159.4	197.6	203.0	194.0	
		SD				NT		SD	13.4	28.3	20.8	14.6	
		ratio	NA	0.84	0.77		0.79	ratio	NA	1.24	1.27	1.22	
Dist. I	+	Mean	278.5	269.0	275.0	NT	274.5	Mean	205.0	176.9	198.4	191.4	5.4
		SD				NT		SD	15.1	20.4	11.9	5.3	
		ratio	NA	0.95	0.99		0.99	ratio	NA	0.86	0.97	0.43	
	-	Mean	336.0	217.0	243.0	NT	280.5	Mean	159.4	195.6	196.2	190.4	
		SD				NT		SD	13.4	33.5	22.0	13.5	
		ratio	NA	0.63	0.72		0.85	ratio	NA	1.23	1.23	1.19	
Dist. II	+	Mean	278.5	267.0	281.0	NT	269.5	Mean	205.0	158.0	192.6	188.4	2.1
		SD				NT		SD	15.1	45.5	21.9	16.15	
		ratio	NA	0.96	1.01		0.97	ratio	NA	0.77	0.94	0.92	
	-	Mean	336.0	272.0	216.0	NT	248.0	Mean	159.4	183.8	187.0	186.0	
		SD				NT		SD	13.4	17.4	13.4	14.9	
		ratio	NA	0.81	0.64		0.74	ratio	NA	1.15	1.17	1.17	

Table 89. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of La Crosse, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	58.0	58.0	51.0	NT	46.0	Mean	53.6	65.4	52.4	48.8	5.6
		SD	NA			NT		SD	4.39	9.48	9.07	9.62	
		ratio		1.00	0.88		0.79	ratio	NA	1.22	0.98	0.91	
	-	Mean	90.0	96.0	87.0	NT	74.0	Mean	53.6	64.4	71.6	59.8	
		ratio	NA	1.07	0.97	NT	0.82	SD	12.65	9.48	8.33	5.80	
								ratio	NA	1.20	1.34	1.12	
Finished water	+	Mean	58.0	54.5	52.0	NT	45.5	Mean	53.6	54.4	42.8	39.6	4.0
		ratio	NA	0.94	0.90	NT	0.78	SD	4.39	6.65	8.81	7.40	
								ratio	NA	1.01	0.80	0.74	
	-	Mean	90.0	106.5	86.0	NT	100.5	Mean	53.6	56.4	56.6	61.6	
		ratio	NA	1.18	0.96	NT	1.12	SD	12.05	9.71	9.79	10.16	
								ratio	NA	1.05	1.06	1.15	
Dist. I	+	Mean	58.0	53.5	50.0	NT	58.0	Mean	53.6	57.0	68.0	46.4	5.4
		ratio	NA	0.92	0.86	NT	1.00	SD	4.39	11.49	4.06	5.13	
								ratio	NA	1.06	6.27	0.87	
	-	Mean	90.0	80.5	101.5	NT	112.5	Mean	53.6	47.8	60.11	58.8	
		ratio	NA	0.89	1.13	NT	1.25	SD	12.05	7.73	9.18	14.2	
								ratio	NA	0.89	1.13	1.10	
Dist. II	+	Mean	58.0	53.5	49.0	NT	47.0	Mean	53.6	55.6	58.6	48.0	2.1
		ratio	NA	0.92	0.84	NT	0.81	SD	4.39	6.73	9.94	9.35	
								ratio	NA	1.04	1.09	0.90	
	-	Mean	90.0	99.5	96.5	NT	99.5	Mean	53.6	53.0	48.0	53.4	
		ratio	NA	1.11	1.07	NT	1.11	SD	12.05	10.65	9.35	10.11	
								ratio	NA	0.99	0.90	1.00	

Table 90. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of La Crosse, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	5.6
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
	-	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
Finished water	+	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	4.0
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
	-	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
Dist. I	+	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	5.4
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
	-	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
Dist. II	+	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	2.1
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
	-	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	

Table 91. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of La Crosse, Wisconsin. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	58.0	58.0	51.0	NT	46.0	Mean	42.8	38.2	44.4	43.0	5.6
		ratio	NA	1.00	0.88	NT	0.79	SD	13.1	9.26	9.74	10.3	
								ratio	NA	0.89	1.04	1.01	
	-	Mean	90.0	96.0	87.0	NT	74.0	Mean	31.4	33.2	44.2	37.0	
		ratio	NA	1.07	0.97	NT	0.82	SD	3.36	4.76	7.19	8.72	
								ratio	NA	1.06	1.41	1.18	
Finished water	+	Mean	58.0	54.5	52.0	NT	45.5	Mean	42.8	41.4	41.6	36.2	4.0
		ratio	NA	0.94	0.90	NT	0.78	SD	13.1	7.76	9.32	6.72	
								ratio	NA	0.97	0.97	0.85	
		Mean	90.0	106.5	86.0	NT	100.5	Mean	31.4	30.0	36.2	43.6	
		ratio	NA	1.18	0.96	NT	1.12	SD	3.36	8.03	6.72	11.4	
								ratio	NA	0.96	1.15	1.39	
Dist. I	+	Mean	58.0	53.5	50.0	NT	58.0	Mean	42.8	30.8	39.8	38.8	5.4
		ratio	NA	0.92	0.86	NT	1.00	SD	13.1	11.84	7.85	9.83	
								ratio	NA	0.72	0.93	0.91	
	-	Mean	90.0	80.5	101.5	NT	112.5	Mean	31.4	30.6	37.6	30.6	
		ratio	NA	0.89	1.13	NT	1.25	SD	3.36	9.79	6.35	6.02	
								ratio	NA	0.98	1.20	0.98	
Dist. II	+	Mean	58.0	53.5	49.0	NT	47.0	Mean	42.8	38.8	38.0	41.2	2.1
		ratio	NA	0.92	0.84	NT	0.81	SD	13.1	3.99	1.22	0.84	
								ratio	NA	0.91	0.89	0.96	
	-	Mean	90.0	99.5	96.5	NT	99.5	Mean	31.4	34.2	33.8	39.0	
		ratio	NA	1.11	1.07	NT	1.11	SD	3.36	3.27	7.40	9.72	
								ratio	NA	1.09	1.08	1.24	

Table 92. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Merced, California. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	161.0	81.0	75.0	116.5	124.5	Mean	93.2	48.8	93.6	60.6	1.3
		ratio	NA	0.50	0.47	0.72	0.77	SD	7.73	7.76	7.37	8.88	
								ratio	NA	0.52	1.00	0.65	
	-	Mean	45.0	38.0	39.5	23.0	24.5	Mean	69.2	42.6	58.0	43.4	
		ratio	NA	0.84	0.88	0.51	0.54	SD	15.64	10.74	12.51	9.52	
								ratio	NA	0.61	0.84	0.62	
Finished water	+	Mean	161.0	103.5	65.5	88.5	66.0	Mean	93.2	82.4	105.2	109.4	0.9
		ratio	NA	0.64	0.41	0.55	0.41	SD	7.73	33.10	11.43	4.16	
								ratio	NA	0.88	1.13	1.17	
	-	Mean	45.0	32.5	32.5	27.5	42.0	Mean	69.2	40.6	50.0	57.0	
		ratio	NA	0.72	0.72	0.61	0.93	SD	15.64	4.83	16.21	17.51	
								ratio	NA	0.59	0.72	0.82	
Dist. I	+	Mean	161.0	121.5	119.0	158.0	156.0	Mean	93.2	94.4	119.4	113.8	1.3
		ratio	NA	0.75	0.74	0.98	0.97	SD	7.73	13.70	16.68	14.82	
								ratio	NA	1.01	1.28	1.22	
	-	Mean	45.0	37.0	38.5	39.5	33.0	Mean	69.2	34.6	43.4	41.0	
		ratio	NA	0.82	0.86	0.88	0.73	SD	15.64	4.67	10.74	15.38	
								ratio	NA	0.50	0.63	0.59	
Dist. II	+	Mean	161.0	64.0	118.0	74.5	41.0	Mean	93.2	145.8	118.6	95.4	2.8
		ratio	NA	0.40	0.73	0.46	0.27	SD	7.73	14.82	27.17	20.2	
								ratio	NA	1.56*	1.27	1.02	
	-	Mean	45.0	44.0	47.5	33.5	44.0	Mean	69.2	38.2	43.0	32.2	
		ratio	NA	0.98	1.06	0.74	0.98	SD	15.64	6.76	22.02	12.72	
								ratio	NA	0.55	0.62	0.47	

Table 93. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Merced, California. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	313.5	259.5	267.5	208.0	327.0	Mean	125.2	91.8	146.4	149.2	1.3
		SD						SD	14.06	15.12	15.95	18.86	
		ratio	NA	0.83	0.85	0.66	1.04	ratio	NA	0.73	1.17	1.19	
	-	Mean	254.5	156.0	152.5	183.0	171.5	Mean	126.2	77.4	143.8	149.4	
		SD						SD	8.32	8.65	17.43	24.91	
		ratio	NA	0.61	0.60	0.72	0.67	ratio	NA	0.61	1.14	1.18	
Finished water	+	Mean	313.5	176.0	227.5	132.5	195.0	Mean	125.2	135.4	150.4	154.0	0.9
		SD						SD	14.06	18.61	15.27	11.94	
		ratio	NA	0.56	0.73	0.52	0.62	ratio	NA	1.08	1.20	1.23	
	-	Mean	254.5	126.0	132.5	224.0	140.0	Mean	126.2	155.0	156.6	138.0	
		SD						SD	8.32	25.26	12.82	23.47	
		ratio	NA	0.50	0.73	0.71	0.55	ratio	NA	1.23	1.24	1.09	
Dist. I	+	Mean	313.5	165.0	140.0	162.5	112.0	Mean	125.2	115.6	132.6	131.2	1.3
		SD						SD	14.06	17.73	23.50	11.19	
		ratio	NA	0.53	0.45	0.52	0.36	ratio	NA	0.92	1.06	1.05	
	-	Mean	254.5	101.5	143.5	173.0	173.0	Mean	126.2	115.8	135.4	145.0	
		SD						SD	8.32	12.56	6.23	19.94	
		ratio	NA	0.40	0.56	0.68	0.68	ratio	NA	0.92	1.07	1.15	
Dist. II	+	Mean	313.5	156.5	122.0	123.0	103.5	Mean	125.2	137.0	174.0	173.0	2.8
		SD						SD	14.06	5.74	29.59	16.76	
		ratio	NA	0.50	0.39	0.39	0.33	ratio	NA	1.09	1.39	1.38	
	-	Mean	254.5	102.5	128.5	142.0	149.0	Mean	126.2	94.0	149.6	144.4	
		SD						SD	8.32	21.46	7.27	9.84	
		ratio	NA	0.40	0.50	0.56	0.59	ratio	NA	0.74	1.19	1.14	

Table 94. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Merced, California. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	147.0	112.0	119.0	143.5	148.5	Mean	93.6	73.2	129.0	120.8	1.3
		SD						SD	10.57	12.54	38.11	9.01	
		ratio	NA	0.76	0.81	0.97	1.01	ratio	NA	0.78	1.38	1.29	
	-	Mean	66.0	73.0	0.64	105.5	107.5	Mean	85.0	63.4	84.6	86.4	
		SD						SD	13.98	15.71	15.04	15.24	
		ratio	NA	1.11	0.98	1.60*	1.62*	ratio	NA	0.76	1.00	1.02	
Finished water	+	Mean	147.0	60.5	130.5	149.0	94.0	Mean	93.6	83.2	125.4	127.4	0.9
		SD						SD	10.57	18.57	17.62	19.60	
		ratio	NA	0.41	0.89	1.01	0.64	ratio	NA	0.89	1.34	1.36	
	-	Mean	66.0	96.5	77.5	156.5	76.5	Mean	85.0	74.2	94.2	100.0	
		SD						SD	13.98	20.07	15.80	7.68	
		ratio	NA	1.46	1.17	2.37**	1.16	ratio	NA	0.87	1.11	1.18	
Dist. I	+	Mean	147.0	112.5	152.5	168.5	82.5	Mean	93.6	72.8	105.8	129.6	1.3
		SD						SD	10.57	19.20	16.63	20.68	
		ratio	NA	0.77	1.04	1.15	0.56	ratio	NA	0.78	1.13	1.38	
	-	Mean	66.0	91.0	100.5	61.0	98.0	Mean	85.0	65.4	79.8	97.4	
		SD						SD	13.98	4.34	7.53	9.96	
		ratio	NA	1.38	1.52*	0.92	1.48	ratio	NA	0.77	0.93	1.15	
Dist. II	+	Mean	147.0	129.5	49.0	62.5	101.5	Mean	93.6	91.6	101.6	102.0	2.8
		SD						SD	10.57	19.13	11.10	9.92	
		ratio	NA	0.88	0.33	0.42	0.69	ratio	NA	0.98	1.09	1.09	
	-	Mean	66.0	80.5	89.5	58.5	71.5	Mean	85.0	88.8	83.2	80.6	
		SD						SD	13.98	12.91	24.88	18.35	
		ratio	NA	1.22	1.36	0.89	1.08	ratio	NA	1.04	0.98	0.95	

Table 95. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Merced, California. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	24.2	21.6	21.0	20.0	1.3
		SD	NT	NT	NT	NT	NT	SD	4.66	9.40	5.52	4.95	
		ratio						ratio	NA	0.89	0.87	0.83	
	-	Mean	NT	NT	NT	NT	NT	Mean	22.2	19.2	24.0	29.2	
		ratio	NT	NT	NT	NT	NT	SD	3.42	8.29	4.53	8.04	
								ratio	NA	0.86	1.08	1.32	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	24.2	21.6	25.6	29.0	0.9
		ratio	NT	NT	NT	NT	NT	SD	4.66	5.86	7.74	8.27	
								ratio	NA	0.89	1.06	1.20	
	-	Mean	NT	NT	NT	NT	NT	Mean	22.2	24.8	20.0	22.8	
		ratio	NT	NT	NT	NT	NT	SD	3.42	7.66	4.84	7.79	
								ratio	NA	1.12	0.90	1.03	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	24.2	22.8	20.4	21.6	1.3
		ratio	NT	NT	NT	NT	NT	SD	4.66	4.43	5.41	6.66	
								ratio	NA	0.94	0.84	0.89	
	-	Mean	NT	NT	NT	NT	NT	Mean	22.2	20.0	19.8	28.4	
		ratio	NT	NT	NT	NT	NT	SD	3.42	4.95	4.38	7.20	
								ratio	NA	0.90	0.89	1.28	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	24.2	14.8	22.8	16.8	2.8
		ratio	NT	NT	NT	NT	NT	SD	4.66	1.48	4.44	5.12	
								ratio	NA	0.61	0.94	0.69	
	-	Mean	NT	NT	NT	NT	NT	Mean	22.2	14.8	20.2	20.0	
		ratio	NT	NT	NT	NT	NT	SD	3.42	4.15	2.95	3.67	
								ratio	NA	0.67	0.91	0.90	

Table 96. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Merced, California. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	37.5	60.5	41.0	39.0	57.0	Mean	29.6	36.2	36.6	38.6	1.3
		ratio	NA	1.61*	1.09	1.04	1.52*	SD	8.82	9.34	10.64	7.02	
								ratio	NA	1.22	1.24	1.30	
	-	Mean	32.5	38.0	54.0	29.0	18.0	Mean	19.8	21.6	28.4	23.6	
		ratio	NA	1.17	1.66*	0.89	0.55	SD	3.11	7.30	7.77	4.83	
								ratio	NA	1.09	1.43	1.19	
Finished water	+	Mean	37.5	25.5	60.5	70.0	51.5	Mean	29.6	33.4	35.8	33.0	0.9
		ratio	NA	0.68	1.61*	1.87*	1.37	SD	8.82	13.94	15.01	4.53	
								ratio	NA	1.23	1.21	1.11	
		Mean	32.5	19.5	35.0	26.5	21.5	Mean	19.8	28.2	25.8	23.4	
		ratio	NA	0.60	1.08	0.81	0.66	SD	3.11	11.39	6.38	7.40	
								ratio	NA	1.42	1.30	1.18	
Dist. I	+	Mean	37.5	73.0	77.5	94.5	58.5	Mean	29.6	31.4	32.6	32.4	1.3
		ratio	NA	1.95*	2.07**	2.52**	1.56*	SD	8.82	7.09	7.80	5.46	
								ratio	NA	1.06	1.10	1.09	
	-	Mean	32.5	23.0	27.0	28.0	17.5	Mean	19.8	22.4	27.8	27.2	
		ratio	NA	0.71	0.83	0.86	0.53	SD	3.11	5.68	7.29	4.21	
								ratio	NA	1.13	1.40	1.37	
Dist. II	+	Mean	37.5	60.0	50.5	60.5	85.0	Mean	29.6	22.4	37.4	30.6	2.8
		ratio	NA	1.60*	1.35	1.61*	2.27**	SD	8.82	6.88	7.02	8.56	
								ratio	NA	0.76	1.26	1.03	
	-	Mean	32.5	33.5	19.5	21.5	43.0	Mean	19.8	18.2	16.2	19.4	
		ratio	NA	1.03	0.60	0.66	1.32	SD	3.11	3.63	12.68	8.44	
								ratio	NA	0.92	0.82	0.98	

Table 97. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Nampa, Idaho. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	52.0	50.5	53.5	52.0	105.5	Mean	51.4	40.2	40.0	44.0	ND
		SD						SD	3.85	3.27	5.34	16.88	
		ratio	NA	0.97	1.03	1.0	2.03**	ratio	NA	0.78	0.78	0.86	
	-	Mean	54.0	53.0	41.0	58.5	71.5	Mean	52.4	38.6	40.2	45.4	
		SD						SD	2.79	9.24	2.17	6.99	
		ratio	NA	0.98	0.79	1.08	1.32	ratio	NA	0.74	0.77	0.87	
Finished water	+	Mean	52.0	50.0	48.5	52.0	32.0	Mean	51.4	42.8	51.0	57.4	ND
		SD						SD	3.85	13.82	4.42	6.80	
		ratio	NA	0.96	0.93	1.0	0.62	ratio	NA	0.83	0.99	1.12	
	-	Mean	54.0	54.0	46.5	49.5	20.5	Mean	52.4	41.4	47.4	52.5	
		SD						SD	2.79	6.80	3.97	16.41	
		ratio	NA	1.0	0.86	0.92	0.38	ratio	NA	0.79	0.90	1.00	
Dist. I	+	Mean	52.0	47.5	48.5	59.0	69.5	Mean	51.4	40.2	49.2	41.0	6.5
		SD						SD	3.85	14.67	7.98	9.72	
		ratio	NA	0.91	0.93	1.13	1.34	ratio	NA	0.78	0.96	0.80	
	-	Mean	54.0	67.0	57.5	58.0	97.0	Mean	52.4	39.6	47.8	37.6	
		SD						SD	2.79	7.63	5.72	18.40	
		ratio	NA	1.24	1.06	1.07	1.80*	ratio	NA	0.76	0.91	0.72	
Dist. II	+	Mean	52.0	48.5	73.0	55.0	48.5	Mean	51.4	57.0	49.8	41.4	7.6
		SD						SD	3.85	6.24	9.39	1.67	
		ratio	NA	0.93	1.4	1.06	0.93	ratio	NA	1.11	0.97	0.81	
	-	Mean	54.0	52.0	56.0	49.5	41.0	Mean	52.4	41.2	41.0	39.6	
		SD						SD	2.79	7.05	5.74	4.83	
		ratio	NA	0.96	1.04	0.97	0.76	ratio	NA	0.79	0.78	0.76	

Table 98. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Nampa, Idaho. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	95.0	76.0	63.0	92.0	84.0	Mean	226.0	189.8	225.8	215.6	ND
		SD						SD	20.58	45.17	31.74	19.54	
		ratio	NA	0.80	0.66	1.12	0.88	ratio	NA	0.84	1.00	0.95	
	-	Mean	82.0	88.0	76.0	83.0	89.0	Mean	241.2	194.8	244.6	249.4	
		SD						SD	32.51	17.68	11.08	25.64	
		ratio	NA	1.07	0.92	0.87	1.08	ratio	NA	0.81	1.01	1.03	
Finished water	+	Mean	95.0	83.0	83.0	81.5	76.5	Mean	226.0	197.6	218.4	226.4	ND
		SD						SD	20.58	18.45	10.06	7.80	
		ratio	NA	0.87	0.87	0.86	0.81	ratio	NA	0.87	0.97	1.00	
	-	Mean	82.0	112.0	104.0	79.0	92.0	Mean	241.2	201.6	248.6	257.0	
		SD						SD	32.51	48.07	29.71	22.80	
		ratio	NA	1.36	1.26	0.96	1.12	ratio	NA	0.84	1.03	1.07	
Dist. I	+	Mean	95.0	99.0	95.0	105.0	129.0	Mean	226.0	227.8	245.6	248.2	6.5
		SD						SD	20.58	25.97	23.97	12.81	
		ratio	NA	1.04	1.0	1.27	1.36	ratio	NA	1.01	1.09	1.10	
	-	Mean	82.0	103.0	107.5	120.5	105.5	Mean	241.2	276.2	274.8	227.8	
		SD						SD	32.51	19.1	20.89	28.54	
		ratio	NA	1.25	1.13	1.46	1.28	ratio	NA	1.15	1.14	0.94	
Dist. II	+	Mean	95.0	105.5	99.5	90.0	111.5	Mean	226.0	234.0	288.2	235.8	7.6
		SD						SD	20.58	23.40	16.51	24.97	
		ratio	NA	1.11	1.05	0.95	1.17	ratio	NA	1.04	1.28	1.04	
	-	Mean	82.0	115.5	90.5	83.5	92.5	Mean	241.2	239.0	304.8	263.8	
		SD						SD	32.51	23.99	54.69	13.05	
		ratio	NA	1.4	1.10	1.01	1.12	ratio	NA	0.99	1.26	1.09	

Table 99. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Nampa, Idaho. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	44.0	38.0	27.0	28.0	25.0	Mean	57.2	57.2	55.4	63.2	ND
		SD						SD	12.81	6.10	5.54	11.88	
		ratio	NA	0.86	0.61	0.63	0.57	ratio	NA	1.00	0.97	1.10	
	-	Mean	84.0	53.5	81.0	62.0	84.0	Mean	67.8	53.0	80.0	92.0	
		SD						SD	6.22	18.53	10.56	12.02	
		ratio	NA	0.63	0.96	0.74	1.0	ratio	NA	0.78	1.18	1.36	
Finished water	+	Mean	44.0	30.0	28.0	175.0	23.0	Mean	57.2	60.0	64.0	54.4	ND
		SD						SD	12.81	10.60	5.61	8.41	
		ratio	NA	0.68	0.64	0.40	0.52	ratio	NA	1.05	1.12	0.95	
	-	Mean	84.0	72.0	82.5	46.0	16.5	Mean	67.8	49.4	68.6	81.0	
		SD						SD	6.22	12.93	6.11	5.61	
		ratio	NA	0.86	0.98	0.55	0.20	ratio	NA	0.73	1.01	1.19	
Dist. I	+	Mean	44.0	26.5	29.5	32.0	45.0	Mean	57.2	71.2	43.0	50.0	6.5
		SD						SD	12.81	14.20	4.64	9.17	
		ratio	NA	0.60	0.67	0.73	1.02	ratio	NA	1.24	0.75	0.87	
	-	Mean	84.0	72.0	81.5	106.0	117.0	Mean	67.8	74.4	46.8	45.2	
		SD						SD	6.22	7.83	6.14	5.36	
		ratio	NA	0.86	0.97	1.26	1.39	ratio	NA	1.10	0.69	0.67	
Dist. II	+	Mean	44.0	53.0	31.0	35.0	28.0	Mean	57.2	77.2	39.4	36.0	7.6
		SD						SD	12.81	27.32	3.78	7.07	
		ratio	NA	1.20	0.70	0.80	0.64	ratio	NA	1.35	0.69	0.63	
	-	Mean	84.0	70.0	56.5	72.5	69.5	Mean	67.8	84.4	41.8	43.6	
		SD						SD	6.22	12.10	6.06	9.63	
		ratio	NA	0.83	0.67	0.86	0.83	ratio	NA	1.24	0.62	0.64	

Table 100. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Nampa, Idaho. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	ND
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
	-	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
Finished water	+	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	ND
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
	-	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
Dist. I	+	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	6.5
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
	-	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
Dist. II	+	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	7.6
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
	-	Mean	NA	NA	NA	NA	NA	Mean	NT	NT	NT	NT	
		SD	NA	NA	NA	NA	NA	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	

Table 101. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Nampa, Idaho. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	27.0	29.5	36.0	33.0	34.0	Mean	NT	NT	NT	NT	ND
		SD	NA	1.09	1.33	1.22	1.26	SD	NT	NT	NT	NT	
		ratio						ratio	NT	NT	NT	NT	
	-	Mean	31.0	37.5	33.0	46.5	2.85	Mean	NT	NT	NT	NT	
		ratio	NA	1.21	1.06	1.50*	0.92	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
Finished water	+	Mean	27.0	42.0	56.0	40.0	39.0	Mean	NT	NT	NT	NT	ND
		ratio	NA	1.57*	2.07**	1.48	1.44	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
	-	Mean	31.0	27.0	31.0	27.0	21.0	Mean	NT	NT	NT	NT	
		ratio	NA	0.87	1.00	0.87	0.68	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
Dist. I	+	Mean	27.0	45.5	40.5	80.5	41.5	Mean	NT	NT	NT	NT	6.5
		ratio	NA	1.69*	1.50*	2.98**	1.53*	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
	-	Mean	31.0	20.5	24.0	52.0	37.5	Mean	NT	NT	NT	NT	
		ratio	NA	0.66	0.77	1.68*	1.21	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
Dist. II	+	Mean	27.0	51.0	21.0	24.0	21.0	Mean	NT	NT	NT	NT	7.6
		ratio	NA	1.89*	0.77	0.89	0.77	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	
	-	Mean	31.0	14.0	15.5	17.0	14.5	Mean	NT	NT	NT	NT	
		ratio	NA	0.45	0.50	0.55	0.45	SD	NT	NT	NT	NT	
								ratio	NT	NT	NT	NT	

Table 102. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Olympia, Washington. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	40.0	51.5	43.0	48.0	43.0	Mean	51.6	32.0	32.0	45.8	0.2
		SD						SD	5.50	8.86	9.75	10.96	
		ratio	NA	1.29	1.08	1.20	1.08	ratio	NA	0.62	0.62	0.89	
	-	Mean	60.0	51.0	59.5	55.5	29.5	Mean	46.8	35.4	26.4	45.0	
		SD						SD	5.76	5.08	6.31	17.04	
		ratio	NA	0.85	0.99	0.93	0.49	ratio	NA	0.74	0.56	0.96	
Finished water	+	Mean	40.0	42.5	76.5	111.5	111.0	Mean	51.6	31.6	57.4	37.9	0.6
		SD						SD	5.50	7.40	13.30	4.38	
		ratio	NA	1.06	1.91*	2.79**	2.78**	ratio	NA	0.61	1.11	0.73	
	-	Mean	60.0	46.5	53.0	106.0	76.5	Mean	46.8	28.8	31.6	29.8	
		SD						SD	5.76	35.6	7.06	6.18	
		ratio	NA	0.78	0.88	1.77*	1.28	ratio	NA	0.62	0.68	0.64	
Dist. I	+	Mean	40.0	52.5	47.0	53.0	47.0	Mean	51.6	52.4	44.6	38.4	0.4
		SD						SD	5.50	2.30	7.79	10.18	
		ratio	NA	1.31	1.18	1.33	1.18	ratio	NA	1.02	0.66	0.74	
	-	Mean	60.0	42.0	42.0	53.5	43.5	Mean	46.8	46.0	34.6	45.6	
		SD						SD	5.76	10.79	8.62	6.84	
		ratio	NA	0.70	0.70	0.89	0.73	ratio	NA	0.98	0.74	0.97	
Dist. II	+	Mean	40.0	49.0	50.5	43.0	51.0	Mean	51.6	35.2	42.4	43.0	ND
		SD						SD	5.50	14.96	3.21	11.68	
		ratio	NA	1.23	1.26	1.08	1.28	ratio	NA	0.68	0.82	0.83	
	-	Mean	60.0	46.0	41.0	51.0	48.0	Mean	48.8	33.6	39.6	3.42	
		SD						SD	5.76	15.37	2.19	4.97	
		ratio	NA	0.77	0.68	0.85	0.80	ratio	NA	0.72	0.84	0.73	

Table 103. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Olympia, Washington. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	230.5	237.5	173.0	324.0	244.5	Mean	195.6	212.0	207.2	160.2	0.2
		SD						SD	27.13	7.68	36.51	15.07	
		ratio	NA	1.03	0.73	1.41	1.06	ratio	NA	1.08	1.06	0.82	
	-	Mean	227.5	239.0	412.5	238.0	233.5	Mean	183.8	171.8	188.6	153.2	
		SD						SD	21.23	16.50	18.38	10.66	
		ratio	NA	1.05	1.81*	1.05	1.03	ratio	NA	0.93	1.03	0.83	
Finished water	+	Mean	230.5	308.0	319.0	279.0	313.0	Mean	195.6	190.8	196.0	212.6	0.6
		SD						SD	27.13	24.98	24.05	11.99	
		ratio	NA	1.34	1.38	1.21	1.36	ratio	NA	0.98	1.07	1.09	
	-	Mean	227.5	330.5	256.5	274.0	333.5	Mean	183.8	170.2	174.2	188.4	
		SD						SD	21.23	25.26	10.00	11.80	
		ratio	NA	1.45	1.13	1.20	1.47	ratio	NA	0.93	0.95	1.03	
Dist. I	+	Mean	230.5	216.5	241.5	190.0	238.5	Mean	195.6	216.4	206.4	187.2	0.4
		SD						SD	27.13	5.18	5.27	9.88	
		ratio	NA	0.94	1.05	0.82	1.03	ratio	NA	1.11	1.06	0.96	
	-	Mean	227.5	293.5	329.0	256.5	225.5	Mean	183.8	187.8	183.8	167.8	
		SD						SD	21.23	25.07	10.03	26.49	
		ratio	NA	1.29	1.45	1.13	0.99	ratio	NA	1.02	1.00	0.91	
Dist. II	+	Mean	230.5	175.5	223.5	315.5	788.0	Mean	195.6	177.6	205.4	199.0	ND
		SD						SD	27.13	17.62	7.44	13.58	
		ratio	NA	0.76	0.97	1.37	1.25	ratio	NA	0.91	1.05	1.02	
	-	Mean	227.5	334.5	277.5	180.0	237.0	Mean	183.8	176.3	170.0	182.2	
		SD						SD	21.23	18.05	14.47	17.94	
		ratio	NA	1.47	1.22	0.79	1.04	ratio	NA	0.96	0.92	0.99	

Table 104. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Olympia, Washington. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	46.5	33.5	31.5	32.5	47.5	Mean	53.2	66.2	28.0	16.0	0.2
		SD						SD	27.01	11.95	3.31	1.87	
		ratio	NA	0.72	0.68	0.70	1.02	ratio	NA	1.24	0.53	0.30	
	-	Mean	73.0	68.0	64.0	76.5	59.0	Mean	61.6	66.0	22.2	16.0	
		SD						SD	5.90	15.89	6.14	2.0	
		ratio	NA	0.93	0.88	1.05	0.81	ratio	NA	1.07	0.36	0.26	
Finished water	+	Mean	46.5	29.0	137.0	98.5	76.0	Mean	53.2	57.8	77.8	70.2	0.6
		SD						SD	27.01	8.81	15.83	8.23	
		ratio	NA	0.62	2.94**	2.12**	1.63**	ratio	NA	1.09	1.46	1.32	
	-	Mean	73.0	53.0	109.5	185.0	159.5	Mean	61.6	52.6	76.4	75.4	
		SD						SD	5.90	13.94	10.40	10.06	
		ratio	NA	0.73	1.50**	2.53**	2.18**	ratio	NA	0.85	1.24	1.22	
Dist. I	+	Mean	46.5	64.5	41.0	10.5	39.0	Mean	53.2	67.2	75.0	63.0	0.4
		SD						SD	27.01	9.07	13.27	8.51	
		ratio	NA	1.39	0.88	0.87	0.84	ratio	NA	1.26	1.41	1.18	
	-	Mean	73.0	42.5	78.5	76.0	70.0	Mean	61.6	73.2	62.2	53.8	
		SD						D	5.90	14.68	10.33	8.13	
		ratio	NA	0.58	1.08	1.04	0.96	ratio	NA	1.19	1.01	0.87	
Dist. II	+	Mean	46.5	34.0	31.0	16.5	22.0	Mean	53.2	55.4	81.8	62.8	ND
		SD						SD	27.01	6.54	5.36	10.80	
		ratio	NA	0.73	0.67	0.35	0.47	ratio	NA	1.04	1.54*	1.18	
	-	Mean	73.0	60.0	72.5	67.5	59.5	Mean	61.6	67.8	69.0	56.6	
		SD						SD	5.90	7.76	9.57	13.96	
		ratio	NA	0.82	0.99	0.92	0.82	ratio	NA	1.10	1.12	0.92	

Table 105. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Olympia, Washington. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	14.2	15.6	13.2	5.6	0.2
		ratio	NT	NT	NT	NT	NT	SD	2.17	1.52	1.64	2.3	
								ratio	NA	1.10	0.93	0.39	
	-	Mean	NT	NT	NT	NT	NT	Mean	16.2	16.8	17.4	5.6	
		ratio	NT	NT	NT	NT	NT	SD	5.16	1.64	1.14	2.7	
								ratio	NA	1.03	1.07	0.34	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	14.2	13.8	13.4	17.2	0.6
		ratio	NT	NT	NT	NT	NT	SD	2.17	4.09	4.22	5.59	
								ratio	NA	0.97	0.94	1.21	
	-	Mean	NT	NT	NT	NT	NT	Mean	16.2	12.8	14.8	17.0	
		ratio	NT	NT	NT	NT	NT	SD	5.16	2.95	2.05	2.12	
								ratio	NA	0.79	0.91	1.05	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	14.2	15.2	14.4	13.8	0.4
		ratio	NT	NT	NT	NT	NT	SD	2.17	2.28	1.52	4.27	
								ratio	NA	1.07	1.01	0.97	
	-	Mean	NT	NT	NT	NT	NT	Mean	16.2	12.6	12.4	10.0	
		ratio	NT	NT	NT	NT	NT	SD	5.16	2.70	2.70	3.81	
								ratio	NA	0.78	0.76	0.61	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	14.2	11.6	16.0	16.2	ND
		ratio	NT	NT	NT	NT	NT	SD	2.17	3.21	4.58	0.84	
								ratio	NA	0.81	1.13	1.14	
	-	Mean	NT	NT	NT	NT	NT	Mean	16.2	11.8	13.6	11.4	
		ratio	NT	NT	NT	NT	NT	SD	5.16	3.70	3.13	6.28	
								ratio	NA	0.72	0.84	0.70	

Table 106. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Olympia, Washington. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	18.5	25.5	16.0	12.0	26.5	Mean	23.2	19.4	14.8	18.4	0.2
		ratio	NA	1.38	0.86	0.84	1.43	SD	3.03	10.26	3.03	5.55	
								ratio	NA	0.84	0.63	0.79	
	-	Mean	16.0	36.5	13.0	13.5	16.0	Mean	22.8	18.6	18.6	12.8	
		ratio	NA	2.28**	0.81	0.84	1.00	SD	4.32	5.12	5.94	2.49	
								ratio	NA	0.82	0.82	0.56	
Finished water	+	Mean	18.5	26.5	35.5	45.5	89.5	Mean	23.2	27.4	20.0	18.6	0.6
		ratio	NA	1.43	1.92*	2.46**	4.84**	SD	3.03	2.70	3.81	3.13	
								ratio	NA	1.18	0.86	0.80	
		Mean	16.0	31.0	25.5	35.5	18.5	Mean	22.8	16.2	17.4	9.4	
		ratio	NA	1.94*	1.59*	2.21**	1.16	SD	4.32	4.97	5.37	3.4	
								ratio	NA	0.71	0.76	0.41	
Dist. I	+	Mean	18.5	21.0	15.5	17.0	3.05	Mean	23.2	19.6	31.2	21.2	0.4
		ratio	NA	1.13	0.84	0.92	1.64*	SD	3.03	5.86	4.55	4.76	
								ratio	NA	0.84	1.34	0.91	
	-	Mean	16.0	19.5	20.0	17.0	18.0	Mean	22.8	19.0	16.4	20.0	
		ratio	NA	1.22	1.25	1.02	1.13	SD	4.32	4.24	2.41	3.24	
								ratio	NA	0.83	0.72	0.86	
Dist. II	+	Mean	18.5	12.0	16.0	17.5	14.0	Mean	23.2	25.4	25.8	16.4	ND
		ratio	NA	0.65	0.86	0.95	0.76	SD	3.03	6.84	4.21	5.18	
								ratio	NA	1.09	1.11	0.70	
	-	Mean	16.0	16.0	14.5	17.5	12.0	Mean	22.8	16.8	15.0	18.6	
		ratio	NA	1.00	0.91	1.09	0.75	SD	4.32	2.39	2.0	7.37	
								ratio	NA	0.74	0.66	0.82	

Table 107. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of San Luis Obispo, California. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	48.0	65.5	59.5	71.0	54.5	Mean	72.6	47.4	65.4	53.2	0.4
		ratio	NA	1.36	1.24	1.48	1.14	SD	7.89	10.09	11.80	9.26	
								ratio	NA	0.65	0.90	0.73	
	-	Mean	53.0	46.0	51.0	45.5	46.5	Mean	55.4	39.0	43.2	34.2	
		ratio	NA	0.87	0.96	0.86	0.88	SD	9.86	9.02	10.69	5.07	
								ratio	NA	0.70	0.78	0.62	
Finished water	+	Mean	48.0	48.0	44.0	65.0	75.0	Mean	72.6	51.8	54.4	49.3	3.1
		ratio	NA	1.00	0.92	1.35	1.56*	SD	7.89	13.29	13.01	9.50	
								ratio	NA	0.71	0.75	0.68	
	-	Mean	53.0	72.0	46.0	44.5	46.0	Mean	55.4	42.4	44.4	44.4	
		ratio	NA	1.36	0.87	0.84	0.87	SD	9.86	14.74	10.88	14.74	
								ratio	NA	0.77	0.80	0.80	
Dist. I	+	Mean	48.0	63.0	75.0	74.0	67.0	Mean	72.6	51.8	58.4	43.6	1.5
		ratio	NA	1.31	1.56*	1.54*	1.40	SD	7.89	8.64	6.02	14.69	
								ratio	NA	0.71	0.80	0.60	
	-	Mean	53.0	63.0	65.5	50.5	52.0	Mean	55.4	32.6	34.2	30.8	
		ratio	NA	1.19	1.23	0.95	0.98	SD	9.86	6.19	10.03	3.77	
								ratio	NA	0.59	0.62	0.56	
Dist. II	+	Mean	48.0	66.5	65.0	57.5	49.0	Mean	72.6	49.6	49.0	56.2	1.2
		ratio	NA	1.39	1.35	1.20	1.02	SD	7.89	12.34	6.00	14.44	
								ratio	NA	0.69	0.67	0.77	
	-	Mean	53.0	47.5	57.0	65.0	46.5	Mean	55.4	45.6	36.6	34.6	
		ratio	NA	0.90	1.08	1.23	0.88	SD	9.86	15.87	8.62	9.79	
								ratio	NA	0.82	0.66	0.62	

Table 108. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of San Luis Obispo, California. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	198.0	286.5	281.5	252.5	225.5	Mean	122.6	109.0	103.8	104.2	0.4
		SD						SD	22.82	0.71	18.33	7.36	
		ratio	NA	1.45	1.42	1.27	1.14	ratio	NA	0.89	0.85	0.85	
	-	Mean	176.0	152.5	189.5	205.5	137.0	Mean	98.8	86.8	74.2	113.4	
		SD						SD	19.92	10.33	10.45	18.23	
		ratio	NA	0.87	1.08	1.17	0.78	ratio	NA	0.88	0.75	1.15	
Finished water	+	Mean	198.0	268.0	251.0	308.0	278.0	Mean	122.6	115.6	103.8	127.8	3.1
		SD						SD	22.82	31.65	18.29	31.93	
		ratio	NA	1.35	1.27	1.56*	1.40	ratio	NA	0.94	0.85	1.04	
	-	Mean	176.0	129.0	259.5	244.0	203.0	Mean	98.8	113.0	67.8	89.2	
		SD						SD	19.92	30.41	5.76	24.00	
		ratio	NA	0.73	1.47	1.39	1.15	ratio	NA	1.14	0.69	0.90	
Dist. I	+	Mean	198.0	128.5	259.0	257.0	227.5	Mean	122.6	103.8	108.2	104.6	1.5
		SD	4.95					SD	22.82	17.98	16.06	12.88	
		ratio		0.64	1.31	1.30	1.29	ratio	NA	0.84	0.88	0.85	
	-	Mean	176.0	246.0	243.0	290.0	193.5	Mean	98.8	102.2	84.0	77.2	
		SD						SD	19.92	9.12	11.98	12.91	
		ratio	NA	1.40	1.38	1.65*	1.10	ratio	NA	1.03	0.85	0.78	
Dist. II	+	Mean	198.0	243.5	247.0	213.5	198.0	Mean	122.6	97.0	89.0	90.6	1.2
		SD						SD	22.82	14.21	11.87	10.43	
		ratio	NA	1.09	1.25	1.08	1.00	ratio	NA	0.79	0.73	0.74	
	-	Mean	176.0	191.0	152.0	237.5	152.5	Mean	98.8	101.8	91.8	75.0	
		SD						SD	19.92	21.05	10.87	7.11	
		ratio	NA	1.23	0.86	1.35	0.87	ratio	NA	1.03	0.93	0.76	

Table 109. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of San Luis Obispo, California. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	63.5	51.5	51.5	57.5	64.0	Mean	54.0	59.8	64.4	70.4	0.4
		SD						SD	5.61	15.53	9.40	14.54	
		ratio	NA	0.81	0.81	0.91	1.01	ratio	NA	1.11	1.19	1.30	
	-	Mean	143.5	102.5	84.5	113.5	106.0	Mean	44.8	50.6	50.2	78.6	
		SD						SD	5.54	17.71	2.59	6.31	
		ratio	NA	0.71	0.59	0.79	0.73	ratio	NA	1.13	1.12	1.75*	
Finished water	+	Mean	63.5	73.5	49.0	114.0	46.5	Mean	54.0	63.8	56.6	54.0	3.1
		SD						SD	5.61	10.50	14.26	12.21	
		ratio	NA	1.16	0.77	1.80*	0.73	ratio	NA	1.18	1.05	1.00	
	-	Mean	143.5	78.0	103.0	106.0	131.0	Mean	44.8	36.8	42.2	37.8	
		SD						SD	5.54	4.60	5.89	7.85	
		ratio	NA	0.54	0.71	0.74	0.91	ratio	NA	0.82	0.94	0.84	
Dist. I	+	Mean	63.5	66.0	51.0	48.5	67.0	Mean	54.0	54.2	48.2	54.6	1.5
		SD						SD	5.61	6.10	5.22	8.41	
		ratio	NA	1.04	0.80	0.76	1.06	ratio	NA	1.00	0.89	1.01	
	-	Mean	143.5	46.0	39.5	42.0	51.0	Mean	44.8	31.6	57.4	52.6	
		SD						SD	5.54	12.74	12.14	11.15	
		ratio	NA	0.32	0.28	0.29	0.36	ratio	NA	0.71	1.28	1.17	
Dist. II	+	Mean	63.5	60.0	63.0	91.0	106.5	Mean	54.0	52.6	105.6	56.8	1.2
		SD						SD	5.61	8.11	18.53	13.22	
		ratio	NA	0.94	0.99	1.43	1.68*	ratio	NA	0.97	1.96*	1.05	
	-	Mean	143.5	53.0	57.0	124.0	98.5	Mean	44.8	42.8	98.4	53.6	
		SD						SD	5.54	7.98	22.58	4.33	
		ratio	NA	0.36	0.40	0.86	0.69	ratio	NA	0.96	2.20**	1.20	

Table 110. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of San Luis Obispo, California. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	16.5	16.2	17.8	23.8	0.4
		ratio	NT	NT	NT	NT	NT	SD	4.93	6.3	4.32	4.87	
								ratio	NA	0.98	1.07	1.43	
	-	Mean	NT	NT	NT	NT	NT	Mean	19.4	18.0	21.4	15.0	
		ratio	NT	NT	NT	NT	NT	SD	3.65	10.79	10.45	4.97	
								ratio	NA	0.93	1.10	0.77	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	16.5	13.6	18.2	20.2	3.1
		ratio	NT	NT	NT	NT	NT	SD	4.93	4.88	2.17	6.06	
								ratio	NA	0.82	1.10	1.22	
	-	Mean	NT	NT	NT	NT	NT	Mean	19.4	24.2	21.2	12.6	
		ratio	NT	NT	NT	NT	NT	SD	3.65	12.07	13.33	5.50	
								ratio	NA	1.25	1.09	0.65	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	16.5	16.8	19.8	16.2	1.5
		ratio	NT	NT	NT	NT	NT	SD	4.93	5.07	9.93	4.66	
								ratio	NA	1.01	1.19	0.98	
	-	Mean	NT	NT	NT	NT	NT	Mean	19.4	13.6	19.0	13.2	
		ratio	NT	NT	NT	NT	NT	SD	3.65	3.78	3.39	3.96	
								ratio	NA	0.70	0.98	0.68	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	16.5	14.6	17.6	18.0	1.2
		ratio	NT	NT	NT	NT	NT	SD	4.93	6.47	7.63	1.87	
								ratio	NA	0.88	1.06	1.08	
	-	Mean	NT	NT	NT	NT	NT	Mean	19.4	13.0	15.6	13.8	
		ratio	NT	NT	NT	NT	NT	SD	3.65	2.55	2.07	6.98	
								ratio	NA	0.67	0.80	0.71	

Table 111. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of San Luis Obispo, California. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	21.5	17.0	22.0	17.0	23.0	Mean	30.4	26.8	33.2	33.4	0.4
		ratio	NA	0.79	1.02	0.79	1.07	SD	5.81	6.83	5.76	7.98	
								ratio	NA	0.88	1.09	1.10	
	-	Mean	19.0	20.0	11.5	17.0	22.0	Mean	22.2	20.6	21.5	18.2	
		ratio	NA	1.05	0.61	0.89	1.16	SD	5.50	5.22	7.92	2.39	
								ratio	NA	0.93	0.96	0.82	
Finished water	+	Mean	21.5	34.0	28.0	39.0	37.5	Mean	30.4	33.2	27.6	29.0	3.1
		ratio	NA	1.58*	1.30	1.83*	1.74*	SD	5.81	3.83	6.77	6.36	
								ratio	NA	1.09	0.91	0.95	
		Mean	19.0	24.5	25.5	42.5	35.0	Mean	22.2	23.8	21.4	18.4	
		ratio	NA	1.29	1.34	2.24**	1.84*	SD	5.50	4.32	5.18	7.40	
								ratio	NA	1.07	0.96	0.82	
Dist. I	+	Mean	21.5	19.0	10.5	21.0	16.0	Mean	30.4	38.6	36.8	33.8	1.5
		ratio	40.1	0.88	0.49	0.98	0.74	SD	5.81	3.13	8.64	6.72	
								ratio	NA	1.27	1.21	1.11	
	-	Mean	19.0	36.5	35.0	28.5	26.5	Mean	22.2	27.2	25.6	23.8	
		ratio	NA	1.92*	1.84*	1.50*	1.39	SD	5.50	8.93	7.37	8.53	
								ratio	NA	1.23	1.15	1.07	
Dist. II	+	Mean	21.5	31.0	25.0	52.5	51.5	Mean	30.4	37.0	38.8	33.0	1.2
		ratio	NA	1.44	1.16	2.44**	2.40**	SD	5.81	4.36	6.30	5.15	
								ratio	NA	1.22	1.28	1.09	
	-	Mean	19.0	31.5	38.0	39.0	26.0	Mean	22.2	38.4	26.4	22.2	
		ratio	NA	1.66*	2.08**	2.05**	1.37	SD	5.50	11.72	7.77	3.63	
								ratio	NA	1.73*	1.19	1.00	

Table 112. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Tuscalosa, Alabama. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	26.5	34.0	24.5	26.0	17.5	Mean	114.8	73.6	65.4	70.6	4.0
		SD						SD	6.42	16.95	12.48	7.33	
		ratio	NA	1.28	0.92	0.98	0.66	ratio	NA	0.64	0.57	0.61	
	-	Mean	46.5	19.5	24.5	17.0	29.0	Mean	80.2	57.0	50.8	60.0	
		SD						SD	9.81	7.21	10.52	12.12	
		ratio	NA	0.42	0.53	0.37	0.62	ratio	NA	0.71	0.63	0.74	
Finished water	+	Mean	26.5	31.0	30.5	28.5	24.0	Mean	114.8	83.4	97.6	77.6	2.1
		SD						SD	6.42	22.17	3.97	9.15	
		ratio	NA	1.16	1.15	1.08	0.91	ratio	NA	0.72	0.85	0.68	
	-	Mean	46.5	36.5	27.0	17.5	27.0	Mean	80.2	76.4	8.2	67.2	
		SD						SD	9.81	13.48	5.26	15.29	
		ratio	NA	0.78	0.58	0.38	0.58	ratio	NA	0.95	1.00	0.83	
Dist. I	+	Mean	26.5	35.5	24.0	28.5	22.0	Mean	114.8	95.9	96.4	80.6	44.3
		SD						SD	6.42	21.11	17.5	13.24	
		ratio	NA	1.34	0.91	1.08	0.83	ratio	NA	0.83	0.84	0.70	
	-	Mean	46.5	21.0	15.5	22.5	23.0	Mean	80.2	76.0	68.6	53.8	
		SD						SD	9.81	12.79	5.77	13.44	
		ratio	NA	0.45	0.33	0.48	0.49	ratio	NA	0.94	0.85	3.18**	
Dist. II	+	Mean	26.5	39.5	28.5	23.0	25.5	Mean	114.8	89.0	86.6	63.2	27.2
		SD						SD	6.42	19.0	16.46	7.43	
		ratio	NA	1.49	1.08	0.87	0.96	ratio	NA	0.77	0.75	0.55	
	-	Mean	46.5	22.0	22.0	21.5	45.5	Mean	80.2	69.4	55.8	68.2	
		SD						SD	9.81	17.81	10.80	7.29	
		ratio	NA	0.47	0.47	0.46	0.97	ratio	NA	0.86	0.69	0.85	

Table 113. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Tuscalosa, Alabama. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	98.0	84.5	80.0	81.5	77.0	Mean	263.2	281.8	240.0	262.6	4.0
		SD						SD	19.18	21.77	33.40	26.82	
		ratio	NA	0.86	0.82	0.83	0.79	ratio	NA	1.07	0.91	0.99	
	-	Mean	100.0	114.5	90.0	96.5	84.5	Mean	331.2	280.2	220.6	220.2	
		SD						SD	29.29	37.56	24.76	23.27	
		ratio	NA	1.15	0.90	0.97	0.85	ratio	NA	0.85	0.66	0.66	
Finished water	+	Mean	98.0	136.5	114.5	120.5	100.0	Mean	263.2	260.2	259.2	232.0	2.1
		SD						SD	19.18	35.12	28.21	14.61	
		ratio	NA	1.40	1.17	1.23	1.02	ratio	NA	0.98	0.98	0.88	
	-	Mean	100.0	130.5	122.0	119.0	94.0	Mean	331.2	297.8	246.8	232.8	
		SD						SD	29.29	18.96	35.17	8.53	
		ratio	NA	1.30	1.22	1.19	0.94	ratio	NA	0.89	0.74	0.70	
Dist. I	+	Mean	98.0	88.5	84.5	90.0	84.5	Mean	263.2	242.2	260.6	252.6	44.3
		SD						SD	19.18	30.16	41.43	12.01	
		ratio	NA	0.90	0.86	0.91	0.86	ratio	NA	0.92	0.99	0.96	
	-	Mean	100.0	94.5	99.0	95.0	81.0	Mean	331.2	294.7	259.0	223.8	
		SD						SD	29.29	31.97	39.32	16.81	
		ratio	NA	0.95	0.99	0.95	0.81	ratio	NA	0.89	0.78	0.67	
Dist. II	+	Mean	98.0	86.0	96.5	88.0	103.0	Mean	263.2	247.0	254.4	238.0	27.2
		SD						SD	19.18	43.29	27.68	40.01	
		ratio	NA	0.88	0.98	0.90	1.05	ratio	NA	0.93	0.96	0.90	
	-	Mean	100.0	95.0	81.0	84.0	90.5	Mean	331.2	292.6	259.6	237.4	
		SD						SD	29.29	54.69	23.67	24.04	
		ratio	NA	0.95	0.81	0.84	0.91	ratio	NA	0.88	0.78	0.71	

Table 114. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Tuscalosa, Alabama. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	45.0	41.0	31.0	28.0	26.0	Mean	44.8	41.8	44.6	74.8	4.0
		SD						SD	7.98	6.02	8.62	7.53	
		ratio	NA	0.91	0.68	0.62	0.58	ratio	NA	0.93	1.00	1.66*	
	-	Mean	54.0	48.0	50.0	41.5	37.5	Mean	54.4	62.0	53.6	62.2	
		SD						SD	4.10	5.57	6.95	19.15	
		ratio	NA	0.89	0.92	0.77	0.69	ratio	NA	1.14	0.98	1.14	
Finished water	+	Mean	45.0	50.0	55.5	67.5	35.0	Mean	44.8	35.2	57.0	71.2	2.1
		SD						SD	7.98	4.92	7.48	12.26	
		ratio	NA	1.11	1.23	1.50*	0.78	ratio	NA	0.78	1.27	1.59*	
	-	Mean	54.0	64.5	73.0	68.5	82.5	Mean	54.4	59.6	63.8	89.4	
		SD						SD	4.10	9.61	16.75	7.70	
		ratio	NA	1.19	1.35	1.27	1.53*	ratio	NA	1.09	1.17	1.60*	
Dist. I	+	Mean	45.0	45.0	43.0	26.5	33.5	Mean	44.8	36.0	52.0	63.8	44.3
		SD						SD	7.98	6.36	7.48	14.23	
		ratio	NA	1.00	0.96	0.59	0.74	ratio	NA	0.80	1.16	1.42	
	-	Mean	54.0	37.5	27.0	34.0	30.5	Mean	54.4	66.4	74.8	72.8	
		SD						SD	4.10	15.71	5.26	13.31	
		ratio	NA	0.6	0.5	0.63	0.56	ratio	NA	1.22	1.37	1.33	
Dist. II	+	Mean	45.0	43.0	42.0	38.0	46.5	Mean	44.8	31.8	46.4	59.2	27.2
		SD						SD	7.98	4.38	11.50	14.06	
		ratio	NA	0.96	0.93	0.84	1.03	ratio	NA	0.71	0.23	1.32	
	-	Mean	54.0	38.0	40.0	38.0	36.0	Mean	54.4	65.0	79.4	72.8	
		SD						SD	4.10	10.17	12.76	13.94	
		ratio	NA	0.70	0.74	0.73	0.67	ratio	NA	1.19	1.45	1.33	

Table 115. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Tuscalosa, Alabama. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	17.8	15.4	13.2	11.4	4.0
		SD	NT	NT	NT	NT	NT	SD	5.26	2.51	5.07	5.13	
		ratio						ratio	NA	0.58	0.74	0.64	
	-	Mean	NT	NT	NT	NT	NT	Mean	11.2	6.6	12.8	7.6	
		SD	NT	NT	NT	NT	NT	SD	4.87	1.14	4.32	4.45	
		ratio						ratio	NA	0.86	1.14	0.67	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	17.8	NT	17.6	15.4	2.1
		SD	NT	NT	NT	NT	NT	SD	5.26	NT	4.88	4.34	
		ratio						ratio	NA	NT	0.98	0.86	
	-	Mean	NT	NT	NT	NT	NT	Mean	11.2	NT	9.4	7.6	
		SD	NT	NT	NT	NT	NT	SD	4.87	NT	4.16	4.83	
		ratio						ratio	NA	NT	0.84	0.67	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	17.8	20.2	22.4	14.6	44.3
		SD	NT	NT	NT	NT	NT	SD	5.26	7.46	6.31	2.70	
		ratio						ratio	NA	1.13	1.26	0.82	
	-	Mean	NT	NT	NT	NT	NT	Mean	11.2	6.80	12.4	13.6	
		SD	NT	NT	NT	NT	NT	SD	4.87	3.63	3.13	1.34	
		ratio						ratio	NA	1.45	1.10	1.24	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	17.8	18.4	17.4	13.0	27.2
		SD	NT	NT	NT	NT	NT	SD	5.26	4.83	6.73	6.36	
		ratio						ratio	NA	1.03	0.97	1.16	
	-	Mean	NT	NT	NT	NT	NT	Mean	11.2	8.8	12.8	12.8	
		SD	NT	NT	NT	NT	NT	SD	4.87	3.11	3.27	2.59	
		ratio						ratio	NA	0.78	1.14	1.14	

Table 116. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Tuscalosa, Alabama. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	15.0	18.0	16.5	16.5	11.0	Mean	23.0	21.8	21.8	12.4	4.0
		SD						SD	5.70	4.97	3.83	4.10	
		ratio	NA	1.2	1.1	1.1	0.73	ratio	NA	0.94	0.94	0.53	
	-	Mean	13.5	14.0	13.5	11.0	9.5	Mean	17.2	12.0	18.0	11.0	
		SD						SD	3.11	4.12	4.0	3.61	
		ratio	NA	1.03	1.0	0.81	0.70	ratio	NA	0.69	1.04	0.63	
Finished water	+	Mean	15.0	17.0	15.5	19.5	15.0	Mean	23.0	20.2	28.6	21.8	2.1
		SD						SD	5.70	3.27	6.43	5.22	
		ratio	NA	1.13	1.03	1.30	1.0	ratio	NA	0.86	1.24	0.94	
		Mean	13.5	14.0	17.5	11.0	16.5	Mean	17.2	12.2	15.4	17.8	
		SD						SD	3.11	3.96	2.41	7.29	
		ratio	NA	1.04	1.30	0.81	1.22	ratio	NA	0.70	0.89	1.03	
Dist. I	+	Mean	15.0	12.0	20.0	15.5	15.0	Mean	23.0	19.0	18.6	23.2	44.3
		SD						SD	5.70	5.24	6.66	4.27	
		ratio	NA	0.80	1.33	1.03	1.0	ratio	NA	0.82	0.80	1.00	
	-	Mean	13.5	12.5	14.5	13.0	8.5	Mean	17.2	19.4	17.2	14.0	
		SD						SD	3.11	3.34	3.56	3.81	
		ratio	NA	0.93	1.07	0.96	0.62	ratio	NA	1.12	1.00	0.81	
Dist. II	+	Mean	15.0	13.5	11.0	12.5	11.0	Mean	23.0	20.2	27.0	22.2	27.2
		SD						SD	5.70	7.33	3.54	4.55	
		ratio	NA	0.90	0.73	0.83	0.73	ratio	NA	0.88	1.18	1.00	
	-	Mean	13.5	17.0	6.5	14.0	7.5	Mean	17.2	18.6	16.0	17.0	
		SD						SD	3.11	8.11	2.64	2.92	
		ratio	NA	1.26	0.48	1.04	0.56	ratio	NA	1.08	0.93	1.18	

Table 117. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Wheeling, West Virginia. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	86.0	NT	NT	NT	58.0	Mean	76.8	69.6	33.4	25.8	1586.1
		ratio	NA	NT	NT	NT	0.67	SD	7.1	16.3	3.4	4.2	
								ratio	NA	0.91	0.44	0.34	
	-	Mean	55.0	NT	NT	NT	25.5	Mean	50.4	51.6	47.4	36.2	
		ratio	NA	NT	NT	NT	0.46	SD	9.1	11.2	6.7	8.8	
								ratio	NA	1.02	0.94	0.72	
Finished water	+	Mean	86.0	NT	NT	NT	54.0	Mean	76.8	79.0	82.4	74.4	138.5
		ratio	NA	NT	NT	NT	0.63	SD	7.1	17.5	12.2	6.4	
								ratio	NA	1.03	1.07	0.97	
	-	Mean	55.0	NT	NT	NT	28.5	Mean	50.4	47.0	45.0	41.6	
		ratio	NA	NT	NT	NT	0.52	SD	9.1	6.4	3.7	5.6	
								ratio	NA	0.93	0.89	0.83	
Dist. I	+	Mean	86.0	NT	NT	NT	58.0	Mean	76.8	92.2	89.0	75.0	101.1
		ratio	NA	NT	NT	NT	0.67	SD	7.1	15.4	12.8	5.7	
								ratio	NA	1.20	1.16	0.98	
	-	Mean	55.0	NT	NT	NT	32.0	Mean	50.4	48.6	45.0	40.6	
		ratio	NA	NT	NT	NT	0.58	SD	9.1	9.5	4.1	7.0	
								ratio	NA	0.96	0.89	0.81	
Dist. II	+	Mean	86.0	NT	NT	NT	56.5	Mean	76.8	80.6	87.0	86.2	29.8
		ratio	NA	NT	NT	NT	0.66	SD	7.1	10.5	15.9	7.2	
								ratio	NA	1.60*	1.13	1.12	
	-	Mean	55.0	NT	NT	NT	32.5	Mean	50.4	58.2	49.8	46.2	
		ratio	NA	NT	NT	NT	0.59	SD	9.1	6.9	3.6	5.8	
								ratio	NA	1.16	0.99	0.92	

Table 118. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Wheeling, West Virginia. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	229.8	245.4	278.8	245.8	1586.1
		ratio	NT	NT	NT	NT	NT	SD	45.9	19.5	13.1	21.7	
								ratio	NA	1.07	1.21	1.07	
	-	Mean	NT	NT	NT	NT	NT	Mean	305.4	308.6	330.4	315.2	
		ratio	NT	NT	NT	NT	NT	SD	13.6	35.6	9.6	45.0	
								ratio	NA	1.01	1.08	1.03	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	229.8	246.4	270.8	292.6	138.5
		ratio	NT	NT	NT	NT	NT	SD	45.9	29.0	35.5	19.3	
								ratio	NA	1.07	1.18	1.27	
	-	Mean	NT	NT	NT	NT	NT	Mean	305.4	297.4	323.0	292.6	
		ratio	NT	NT	NT	NT	NT	SD	13.6	38.6	16.2	33.7	
								ratio	NA	0.97	1.06	0.96	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	229.8	234.4	347.4	234.4	101.1
		ratio	NT	NT	NT	NT	NT	SD	45.9	22.7	23.4	22.7	
								ratio	NA	1.02	1.51*	1.02	
	-	Mean	NT	NT	NT	NT	NT	Mean	305.4	294.0	361.6	294.0	
		ratio	NT	NT	NT	NT	NT	SD	13.6	28.9	20.5	28.9	
								ratio	NA	0.96	1.18	0.96	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	229.8	248.2	226.2	242.8	29.8
		ratio	NT	NT	NT	NT	NT	SD	45.9	18.3	43.5	15.7	
								ratio	NA	1.08	0.98	1.06	
	-	Mean	NT	NT	NT	NT	NT	Mean	305.4	327.4	306.2	262.4	
		ratio	NT	NT	NT	NT	NT	SD	13.6	22.9	27.5	38.8	
								ratio	NA	1.07	1.00	0.86	

Table 119. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Wheeling, West Virginia. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	40.3	NT	NT	NT	50.5	Mean	32.8	31.2	24.8	26.6	1586.1
		SD	NA	NT	NT	NT	1.25	SD	6.7	3.5	2.2	6.1	
		ratio						ratio	NA	0.95	0.76	0.81	
	-	Mean	75.7	NT	NT	NT	58.0	Mean	90.6	82.6	90.0	84.2	
		ratio	NA	NT	NT	NT	0.77	SD	11.9	4.7	5.0	16.1	
								ratio	NA	0.91	0.99	0.93	
Finished water	+	Mean	40.3	NT	NT	NT	50.0	Mean	32.8	26.6	26.8	34.4	138.5
		ratio	NA	NT	NT	NT	1.24	SD	6.7	6.9	4.3	4.8	
								ratio	NA	0.81	0.82	1.05	
	-	Mean	75.7	NT	NT	NT	84.0	Mean	90.6	77.0	90.4	85.4	
		ratio	NA	NT	NT	NT	1.11	SD	11.9	4.6	20.7	5.0	
								ratio	NA	0.85	1.00	0.94	
Dist. I	+	Mean	40.3	NT	NT	NT	56.0	Mean	32.8	31.0	30.4	26.8	101.1
		ratio	NA	NT	NT	NT	1.39	SD	6.7	5.0	2.7	2.2	
								ratio	NA	0.95	0.93	0.82	
	-	Mean	75.7	NT	NT	NT	72.5	Mean	90.6	75.2	107.2	93.4	
		ratio	NA	NT	NT	NT	0.96	SD	11.9	10.1	19.5	13.5	
								ratio	NA	0.83	1.18	1.03	
Dist. II	+	Mean	40.3	NT	NT	NT	52.0	Mean	32.8	39.0	34.8	27.6	29.8
		ratio	NA	NT	NT	NT	1.29	SD	6.7	3.9	3.7	4.3	
								ratio	NA	1.19	1.06	0.84	
	-	Mean	75.7	NT	NT	NT	79.0	Mean	90.6	78.0	93.8	92.0	
		ratio	NA	NT	NT	NT	1.04	SD	11.9	6.8	11.7	8.5	
								ratio	NA	0.86	1.04	1.02	

Table 120. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Wheeling, West Virginia. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	20.8	15.8	8.2	12.8	1586.1
		ratio	NT	NT	NT	NT	NT	SD	5.3	2.2	2.2	2.8	
								ratio	NA	0.76	0.39	0.62	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.6	11.8	16.2	16.0	
		ratio	NT	NT	NT	NT	NT	SD	4.4	3.4	3.0	2.9	
								ratio	NA	0.67	0.92	0.91	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	20.8	18.2	13.2	20.6	138.5
		ratio	NT	NT	NT	NT	NT	SD	5.3	2.4	6.0	3.9	
								ratio	NA	0.88	0.64	0.99	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.6	13.6	11.2	17.6	
		ratio	NT	NT	NT	NT	NT	SD	4.4	4.0	3.1	2.3	
								ratio	NA	0.77	0.64	1.01	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	20.8	20.2	16.2	12.6	101.1
		ratio	NT	NT	NT	NT	NT	SD	5.3	2.7	5.5	2.2	
								ratio	NA	0.98	0.78	0.61	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.6	11.2	9.4	12.0	
		ratio	NT	NT	NT	NT	NT	SD	4.4	3.1	2.1	2.8	
								ratio	NA	0.64	0.53	0.68	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	20.8	20.6	14.6	18.6	29.8
		ratio	NT	NT	NT	NT	NT	SD	5.3	2.9	2.5	3.3	
								ratio	NA	0.99	0.70	0.89	
	-	Mean	NT	NT	NT	NT	NT	Mean	17.6	12.0	15.4	11.2	
		ratio	NT	NT	NT	NT	NT	SD	4.4	3.4	3.2	4.4	
								ratio	NA	0.68	0.88	0.98	

Table 121. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Wheeling, West Virginia. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	56.2	43.0	38.0	38.6	1586.1
		ratio	NT	NT	NT	NT	NT	SD	6.7	7.8	4.1	5.6	
								ratio	NA	0.77	0.68	0.69	
	-	Mean	NT	NT	NT	NT	NT	Mean	26.0	34.2	31.2	38.6	
		ratio	NT	NT	NT	NT	NT	SD	7.5	6.8	5.7	7.4	
								ratio	NA	1.32	1.20	1.49	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	56.2	52.4	44.8	55.0	138.5
		ratio	NT	NT	NT	NT	NT	SD	6.7	10.0	7.5	7.4	
								ratio	NA	0.93	0.80	0.98	
	-	Mean	NT	NT	NT	NT	NT	Mean	26.0	20.0	33.0	31.8	
		ratio	NT	NT	NT	NT	NT	SD	7.5	5.9	5.7	5.2	
								ratio	NA	0.77	1.27	1.22	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	56.2	52.8	58.0	58.0	101.1
		ratio	NT	NT	NT	NT	NT	SD	6.7	11.0	10.5	8.9	
								ratio	NA	0.94	1.03	1.03	
	-	Mean	NT	NT	NT	NT	NT	Mean	26.0	16.4	34.4	25.8	
		ratio	NT	NT	NT	NT	NT	SD	7.5	3.4	5.9	6.4	
								ratio	NA	0.63	1.32	0.99	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	56.2	58.4	55.6	45.6	29.8
		ratio	NT	NT	NT	NT	NT	SD	6.7	4.9	9.4	1.2	
								ratio	NA	1.04	0.99	0.81	
	-	Mean	NT	NT	NT	NT	NT	Mean	26.0	19.0	33.0	33.4	
		ratio	NT	NT	NT	NT	NT	SD	7.5	5.8	9.9	5.1	
								ratio	NA	0.73	1.27	1.29	

Table 122. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Wichita Falls, Texas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	47.0	68.0	61.0	64.5	49.5	Mean	63.2	80.0	89.4	94.0	41.3
		SD						SD	11.3	7.0	3.3	9.3	
		ratio	NA	1.45	1.30	1.37	1.05	ratio	NA	1.27	1.41	1.49	
	-	Mean	35.0	79.0	82.0	74.0	76.0	Mean	53.8	65.6	73.8	79.4	
		SD						SD	5.3	8.3	8.9	7.8	
		ratio	NA	2.23**	2.31**	2.08**	2.14**	ratio	NA	1.23	1.37	1.48	
Finished water	+	Mean	47.0	51.5	53.0	48.0	54.5	Mean	63.2	84.8	70.8	79.8	0.2
		SD						SD	11.3	5.1	12.6	11.7	
		ratio	NA	1.10	1.13	1.02	1.16	ratio	NA	1.34	1.12	1.26	
	-	Mean	35.0	45.0	54.5	58.0	80.0	Mean	53.8	58.4	60.4	65.4	
		SD						SD	5.3	6.7	12.5	5.3	
		ratio	NA	1.26	1.53*	1.63*	2.25**	ratio	NA	1.09	1.12	1.22	
Dist. I	+	Mean	47.0	51.5	51.5	47.5	57.0	Mean	63.2	83.6	80.2	77.0	3.2
		SD						SD	11.3	8.6	12.9	14.0	
		ratio	NA	1.10	1.10	1.01	1.21	ratio	NA	1.32	1.27	1.22	
	-	Mean	35.0	51.0	51.0	62.5	70.0	Mean	53.8	56.6	61.2	64.0	
		SD						SD	5.3	4.4	10.6	10.8	
		ratio	NA	1.43	1.43	1.76*	1.97*	ratio	NA	1.05	1.14	1.19	
Dist. II	+	Mean	47.0	51.5	51.5	47.5	57.0	Mean	63.2	78.8	72.8	88.2	2.1
		SD						SD	11.3	13.1	11.0	16.2	
		ratio	NA	1.15	0.83	0.99	1.23	ratio	NA	1.25	1.15	1.40	
	-	Mean	35.0	51.0	51.0	62.5	70.0	Mean	53.8	61.4	63.6	71.2	
		SD						SD	5.3	14.1	13.9	7.2	
		ratio	NA	1.56*	1.10	1.37	1.27	ratio	NA	1.14	1.18	1.32	

Table 123. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Wichita Falls, Texas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	248.5	287.0	290.5	300.0	339.0	Mean	276.0	304.2	268.0	290.4	41.3
		SD						SD	27.6	35.3	22.8	27.3	
		ratio	NA	1.15	1.17	1.21	1.36	ratio	NA	1.10	0.97	1.05	
	-	Mean	297.0	347.0	364.5	349.5	369.0	Mean	231.8	229.6	234.0	252.6	
		SD						SD	13.6	17.2	9.5	23.2	
		ratio	NA	1.17	1.23	1.18	1.24	ratio	NA	0.99	1.01	1.09	
Finished water	+	Mean	248.5	272.0	279.0	308.5	304.5	Mean	276.0	273.4	31.4	382.2	0.2
		SD						SD	27.6	36.9	1.01	23.4	
		ratio	NA	1.09	1.12	1.24	1.23	ratio	NA	0.99	1.01	1.02	
	-	Mean	297.0	342.5	318.5	338.5	379.5	Mean	231.8	250.0	227.0	235.4	
		SD						SD	13.6	14.2	18.0	23.9	
		ratio	NA	1.15	1.07	1.14	1.28	ratio	NA	1.08	0.98	1.02	
Dist. I	+	Mean	248.5	283.4	258.0	278.5	244.5	Mean	276.0	299.8	272.4	284.0	3.2
		SD						SD	27.6	18.7	16.0	31.0	
		ratio	NA	1.14	1.04	1.12	0.98	ratio	NA	1.09	0.99	1.03	
	-	Mean	297.0	266.0	262.0	287.0	297.5	Mean	231.8	251.4	222.6	263.6	
		SD						SD	13.6	13.2	9.7	11.3	
		ratio	NA	0.90	0.88	0.97	1.00	ratio	NA	1.09	0.96	1.14	
Dist. II	+	Mean	248.5	270.0	228.0	219.5	293.0	Mean	276.0	290.0	300.4	312.0	2.1
		SD						SD	27.6	17.5	59.1	26.7	
		ratio	NA	1.09	0.92	0.88	1.18	ratio	NA	1.05	1.09	1.13	
	-	Mean	297.0	254.5	246.5	242.5	267.0	Mean	231.8	275.2	261.6	268.8	
		SD						SD	13.6	18.1	40.9	26.7	
		ratio	NA	0.86	0.83	0.82	0.90	ratio	NA	1.19	1.13	1.14	

Table 124. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Wichita Falls, Texas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	32.5	30.0	39.5	34.0	37.0	Mean	57.6	52.8	49.8	56.6	41.3
		SD						SD	12.9	10.4	4.0	4.9	
		ratio	NA	0.92	1.21	1.05	1.14	ratio	NA	0.92	0.87	0.98	
	-	Mean	43.5	56.5	47.5	66.5	56.5	Mean	55.0	61.2	81.4	77.4	
		SD						SD	11.1	10.1	12.0	8.2	
		ratio	NA	1.30	1.09	1.52*	1.30	ratio	NA	1.11	1.46	1.41	
Finished water	+	Mean	32.5	27.0	35.0	18.5	38.0	Mean	57.6	49.6	54.0	50.4	0.2
		SD						SD	12.9	8.9	9.0	8.3	
		ratio	NA	0.83	1.08	0.57	1.17	ratio	NA	0.86	0.94	0.88	
	-	Mean	43.5	60.0	54.0	56.0	51.5	Mean	55.0	56.6	74.0	85.6	
		SD						SD	11.1	7.0	8.6	9.9	
		ratio	NA	1.38	1.24	1.29	1.18	ratio	NA	1.03	1.35	1.56*	
Dist. I	+	Mean	32.5	30.0	25.5	26.5	32.0	Mean	57.6	52.4	62.8	46.2	3.2
		SD						SD	12.9	8.4	5.6	7.5	
		ratio	NA	0.92	0.78	0.81	0.98	ratio	NA	0.91	1.09	0.80	
	-	Mean	43.5	41.0	62.0	51.0	36.5	Mean	55.0	54.0	80.2	76.0	
		SD						SD	11.1	10.6	6.7	7.7	
		ratio	NA	0.94	1.42	1.17	0.84	ratio	NA	0.98	1.46	1.38	
Dist. II	+	Mean	32.5	34.5	31.0	32.5	24.0	Mean	57.6	66.2	61.2	58.6	2.1
		SD						SD	12.9	9.4	7.7	7.0	
		ratio	NA	1.06	0.95	1.00	0.74	ratio	NA	1.15	1.06	1.02	
	-	Mean	43.5	55.5	42.5	46.0	44.0	Mean	55.0	63.2	80.8	73.4	
		SD						SD	11.1	12.0	11.1	8.4	
		ratio	NA	1.28	0.98	1.06	1.01	ratio	NA	1.15	1.47	1.34	

Table 125. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Wichita Falls, Texas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	19.8	11.8	24.8	22.8	41.3
		SD	NT	NT	NT	NT	NT	SD	3.4	5.2	5.6	4.6	
		ratio						ratio	NA	0.60	1.25	1.15	
	-	Mean	NT	NT	NT	NT	NT	Mean	9.8	9.0	11.8	13.6	
		SD	NT	NT	NT	NT	NT	SD	3.7	4.8	5.1	8.2	
		ratio						ratio	NA	0.92	1.20	1.39	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	19.8	15.4	18.8	18.4	0.2
		SD	NT	NT	NT	NT	NT	SD	3.4	4.5	5.4	3.1	
		ratio						ratio	NA	0.78	0.95	0.93	
	-	Mean	NT	NT	NT	NT	NT	Mean	9.8	6.8	10.6	13.4	
		SD	NT	NT	NT	NT	NT	SD	3.7	0.84	5.2	5.1	
		ratio						ratio	NA	0.69	1.08	1.37	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	19.8	20.6	22.4	25.2	3.2
		SD	NT	NT	NT	NT	NT	SD	3.4	7.7	6.8	3.6	
		ratio						ratio	NA	1.04	1.13	1.27	
	-	Mean	NT	NT	NT	NT	NT	Mean	9.8	9.6	10.6	10.6	
		SD	NT	NT	NT	NT	NT	SD	3.7	3.8	6.2	4.5	
		ratio						ratio	NA	0.98	1.08	1.08	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	19.8	8.6	17.6	24.0	2.1
		SD	NT	NT	NT	NT	NT	SD	3.4	3.8	4.0	4.4	
		ratio						ratio	NA	0.43	0.89	1.21	
	-	Mean	NT	NT	NT	NT	NT	Mean	9.8	9.6	12.0	13.4	
		SD	NT	NT	NT	NT	NT	SD	3.7	2.0	1.9	7.7	
		ratio						ratio	NA	0.99	1.22	1.37	

Table 126. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Wichita Falls, Texas. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay, Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay, Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	17.0	18.5	45.5	30.5	31.0	Mean	18.4	24.2	109.0	165.6	41.3
		ratio	NA	1.09	2.67**	1.79*	1.85*	SD	5.9	4.3	11.6	19.6	
								ratio	NA	1.32	5.92**	9.0**	
	-	Mean	11.0	14.5	17.5	16.5	12.5	Mean	15.4	16.0	18.0	19.0	
		ratio	NA	1.31	1.59*	1.50*	1.13	SD	2.4	4.6	8.2	5.2	
								ratio	NA	1.04	1.17	1.23	
Finished water	+	Mean	17.0	21.0	22.5	22.0	26.5	Mean	18.4	20.2	79.0	97.6	0.2
		ratio	NA	1.24	1.32	1.29	1.56*	SD	5.9	3.7	13.8	17.5	
								ratio	NA	1.10	4.3**	5.3**	
	-	Mean	11.0	18.5	16.0	18.0	11.0	Mean	15.4	14.6	23.0	17.8	
		ratio	NA	1.68*	1.45	1.63*	1.00	SD	2.4	3.5	2.5	7.4	
								ratio	NA	0.95	1.49	1.16	
Dist. I	+	Mean	17.0	20.5	22.5	22.0	30.5	Mean	18.4	25.4	83.6	80.0	3.2
		ratio	NA	1.21	1.32	1.29	1.79*	SD	5.9	3.5	11.5	10.8	
								ratio	NA	1.38	4.5**	4.3**	
	-	Mean	11.0	10.5	10.5	13.0	15.0	Mean	15.4	13.2	17.0	19.4	
		ratio	NA	0.95	0.95	1.18	1.36	SD	2.4	4.0	2.6	6.5	
								ratio	NA	0.86	1.10	1.26	
Dist. II	+	Mean	17.0	26.0	27.5	26.0	26.5	Mean	18.4	28.4	71.2	82.4	2.1
		ratio	NA	1.53*	1.61*	1.52*	1.56*	SD	5.9	3.7	11.5	25.1	
								ratio	NA	1.54*	3.87**	4.48**	
	-	Mean	11.0	13.5	12.0	10.0	23.0	Mean	15.4	17.8	20.2	14.4	
		ratio	NA	1.23	1.10	0.91	2.09**	SD	2.4	4.1	6.5	5.9	
								ratio	NA	1.16	1.31	0.94	

Table 127. Mutagenicity of Salmonella Typhimurium Strain TA98 Exposed to Various Drinking Waters from the City of Yakima, Washington. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	94.5	94.0	88.0	62.0	63.0	Mean	68.2	71.6	72.5	78.0	0.6
		ratio	NA	0.99	0.93	0.65	0.67	SD	7.46	7.70	17.08	9.75	
								ratio	NA	1.05	1.06	1.14	
	-	Mean	58.5	64.0	56.0	43.5	83.5	Mean	72.6	60.0	80.2	67.8	
		ratio	NA	1.09	0.96	0.74	1.43	SD	10.16	6.40	9 81	6.61	
								ratio	NA	0.83	1.10	0.93	
Finished water	+	Mean	94.5	45.5	46.0	51.0	85.5	Mean	68.2	63.4	75.2	80.0	ND
		ratio	NA	0.48	0.49	0.54	0.90	SD	7.46	7.92	7.82	9.22	
								ratio	NA	0.93	1.10	1.17	
	-	Mean	58.5	50.0	47.5	48.0	61.0	Mean	72.6	56.9	67.4	77.6	
		ratio	NA	0.85	0.81	0.82	1.05	SD	10.16	11.10	4.93	5.03	
								ratio	NA	0.78	0.92	1.07	
Dist. I	+	Mean	94.5	50.0	67.5	71.5	64.0	Mean	68.2	56.6	100.8	115.0	0.5
		ratio	NA	0.53	0.71	0.76	0.67	SD	7.46	8.73	16.02	8.83	
								ratio	NA	0.83	1.48	1.69*	
	-	Mean	58.5	55.0	53.0	63.0	61.5	Mean	72.6	51.4	69.0	92.6	
		ratio	NA	0.94	0.91	1.08	1.05	SD	10.16	4.98	11.45	5.27	
								ratio	NA	0.71	0.95	1.28	
Dist. II	+	Mean	94.5	43.0	41.0	42.0	56.5	Mean	68.2	67.6	74.4	66.0	3.4
		ratio	NA	0.46	0.43	0.44	0.59	SD	7.46	4.16	5.50	7.03	
								ratio	NA	0.93	1.21	0.97	
	-	Mean	58.5	55.0	46.0	38.0	67.5	Mean	72.6	59.2	64.6	65.2	
		ratio	NA	0.94	0.79	0.64	1.15	SD	10.16	10.85	9.71	11.01	
								ratio	NA	0.99	0.85	0.76	

Table 128. Mutagenicity of Salmonella Typhimurium Strain TA100 Exposed to Various Drinking Waters from the City of Yakima, Washington. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	253.0	185.0	195.0	185.0	205.0	Mean	259.6	249.0	402.6	260.2	0.6
		SD						SD	41.10	21.48	20.08	26.45	
		ratio	NA	0.73	0.77	0.73	0.81	ratio	NA	0.96	1.55*	1.00	
	-	Mean	237.0	192.0	162.5	252.5	128.0	Mean	292.2	324.4	258.2	264.6	
		SD						SD	18.89	15.11	16.11	14.32	
		ratio	NA	0.81	0.69	1.07	0.54	ratio	NA	1.11	0.88	0.91	
Finished water	+	Mean	253.0	324.5	186.5	170.0	195.0	Mean	259.6	222.4	279.6	244.3	ND
		SD						SD	41.10	23.30	25.37	22.65	
		ratio	NA	1.28	0.73	0.67	0.77	ratio	NA	0.86	1.08	0.94	
	-	Mean	237.0	190.5	195.0	191.0	203.5	Mean	292.2	231.4	265.6	223.6	
		SD						SD	18.89	12.99	24.56	17.91	
		ratio	NA	0.80	0.82	0.80	0.86	ratio	NA	0.79	0.91	0.77	
Dist. I	+	Mean	253.0	449.0	445.0	215.0	259.5	Mean	259.6	221.0	271.6	254.2	0.5
		SD						SD	41.10	28.70	22.50	25.31	
		ratio	NA	1.77*	1.75*	0.84	1.03	ratio	NA	0.85	0.93	0.98	
	-	Mean	237.0	319.5	261.5	292.5	274.0	Mean	292.2	243.6	253.4	260.4	
		SD						SD	18.89	29.11	29.96	20.55	
		ratio	NA	1.34	1.10	1.23	1.16	ratio	NA	0.83	0.87	0.89	
Dist. II	+	Mean	253.0	357.5	239.0	256.5	286.0	Mean	259.6	239.0	273.4	282.6	3.4
		SD						SD	41.10	40.76	28.94	24.63	
		ratio	NA	1.41	0.94	1.01	1.13	ratio	NA	0.92	1.05	1.09	
	-	Mean	237.0	342.0	298.0	315.0	339.5	Mean	292.2	237.0	234.0	273.2	
		SD						SD	18.89	20.64	4.36	43.99	
		ratio	NA	1.44	1.26	1.33	1.43	ratio	NA	0.81	0.80	0.93	

Table 129. Mutagenicity of Salmonella Typhimurium Strain TA1535 Exposed to Various Drinking Waters from the City of Yakima, Washington. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	105.0	60.0	97.5	91.5	79.5	Mean	66.0	72.6	70.06	61.2	0.6
		SD						SD	20.02	12.62	8.20	5.76	
		ratio	NA	0.57	0.93	0.87	0.75	ratio	NA	1.10	1.06	0.93	
	-	Mean	96.0	112.0	115.0	76.5	122.0	Mean	92.0	117.4	98.2	102.0	
		SD						SD	9.35	12.62	17.25	4.53	
		ratio	NA	1.17	1.19	0.80	1.27	ratio	NA	1.28	1.07	1.11	
Finished water	+	Mean	105.0	93.0	92.0	96.5	61.0	Mean	66.0	61.8	60.02	113.2	ND
		SD						SD	20.02	5.31	8.17	9.01	
		ratio	NA	0.99	0.88	0.92	0.58	ratio	NA	0.94	0.91	1.23	
	-	Mean	96.0	104.0	114.0	153.5	116.0	Mean	92.0	96.2	67.4	100.6	
		SD						SD	9.35	10.52	8.02	12.84	
		ratio	NA	1.08	1.19	1.60*	1.21	ratio	NA	1.05	1.02	1.09	
Dist. I	+	Mean	105.0	90.0	60.0	106.5	70.5	Mean	66.0	55.4	63.8	76.8	0.5
		SD						SD	20.02	12.6	11.03	7.95	
		ratio	NA	0.85	0.57	1.01	0.67	ratio	NA	0.84	0.97	1.16	
	-	Mean	96.0	88.0	99.5	122.5	156.0	Mean	92.0	75.4	101.6	104.6	
		SD						SD	9.35	14.50	10.95	4.83	
		ratio	NA	0.88	1.04	1.28	1.63*	ratio	NA	0.82	1.10	1.14	
Dist. II	+	Mean	105.0	46.0	30.5	NT	80.0	Mean	66.0	65.6	65.6	67.6	3.4
		SD						SD	20.02	10.57	6.35	7.44	
		ratio	NA	0.43	0.29	NT	0.76	ratio	NA	0.99	0.99	1.02	
	-	Mean	96.0	80.0	125.0	126.0	115.5	Mean	92.0	80.2	90.2	100.6	
		SD						SD	9.35	7.82	18.14	6.45	
		ratio	NA	0.83	1.30	1.31	1.20	ratio	NA	0.87	0.98	1.09	

Table 130. Mutagenicity of Salmonella Typhimurium Strain TA1537 Exposed to Various Drinking Waters from the City of Yakima, Washington. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	NT	NT	NT	NT	NT	Mean	21.0	20.4	30.2	30.0	0.6
		SD	NT	NT	NT	NT	NT	SD	5.56	6.43	5.26	9.62	
		ratio						ratio	NA	0.97	1.43	1.43	
	-	Mean	NT	NT	NT	NT	NT	Mean	21.6	16.8	32.8	36.6	
		ratio	NT	NT	NT	NT	NT	SD	6.73	2.59	5.81	2.30	
								ratio	NA	0.78	1.52*	1.69	
Finished water	+	Mean	NT	NT	NT	NT	NT	Mean	21.0	27.0	36.2	43.2	ND
		ratio	NT	NT	NT	NT	NT	SD	5.56	14.21	7.96	10.47	
								ratio	NA	1.29	1.72*	2.06**	
	-	Mean	NT	NT	NT	NT	NT	Mean	21.6	25.8	34.0	30.0	
		ratio	NT	NT	NT	NT	NT	SD	6.73	27.7	9.87	6.89	
								ratio	NA	1.19	1.57*	1.39	
Dist. I	+	Mean	NT	NT	NT	NT	NT	Mean	21.0	36.0	34.4	45.2	0.5
		ratio	NT	NT	NT	NT	NT	SD	5.56	4.06	4.45	6.61	
								ratio	NA	1.71*	1.64*	2.15**	
	-	Mean	NT	NT	NT	NT	NT	Mean	21.6	25.8	27.0	39.2	
		ratio	NT	NT	NT	NT	NT	SD	6.73	8.56	2.45	2.26	
								ratio	NA	1.19	1.25	1.81*	
Dist. II	+	Mean	NT	NT	NT	NT	NT	Mean	21.0	34.2	35.2	42.4	3.4
		ratio	NT	NT	NT	NT	NT	SD	5.56	4.76	8.87	5.18	
								ratio	NA	1.63*	1.68*	2.02**	
	-	Mean	NT	NT	NT	NT	NT	Mean	21.6	33.2	31.0	35.5	
		ratio	NT	NT	NT	NT	NT	SD	6.73	5.54	3.93	13.30	
								ratio	NA	1.54*	1.44	1.64*	

Table 131. Mutagenicity of Salmonella Typhimurium Strain TA1538 Exposed to Various Drinking Waters from the City of Yakima, Washington. Results Presented as the Number of Revertants Observed per Plate.

Site	Metabolic Activation[1]	Parameter	Number of Revertants per Plate: Liquid Suspension Assay Dose[2] C	L	M	X	H	Parameter	Plate Incorporation Assay Dose[3] C	1 mℓ	1/2	Full	PNA ng/ℓ
Raw water	+	Mean	23.0	28.5	22.5	28.5	24.0	Mean	23.2	27.2	31.8	23.2	0.6
		SD						SD	3.03	6.76	7.16	4.32	
		ratio	NA	1.24	0.98	1.24	1.04	ratio	NA	1.17	1.37	1.0	
	-	Mean	21.0	16.5	20.0	21.0	22.5	Mean	22.8	21.4	20.4	19.2	
		SD						SD	4.32	4.39	4.78	2.95	
		ratio	NA	0.79	0.95	1.00	1.07	ratio	NA	0.93	0.89	0.84	
Finished water	+	Mean	23.0	22.5	22.5	32.0	21.5	Mean	23.2	21.0	20.4	25.2	ND
		SD						SD	3.03	5.43	5.68	6.14	
		ratio	NA	0.98	0.98	1.39	0.93	ratio	NA	0.91	0.88	1.09	
	-	Mean	21.0	17.5	20.5	25.0	15.0	Mean	22.8	22.4	19.6	24.8	
		SD						SD	4.32	3.65	3.65	3.96	
		ratio	NA	0.83	0.98	1.19	0.71	ratio	NA	0.98	0.86	1.09	
Dist. I	+	Mean	23.0	20.0	15.0	31.0	19.0	Mean	23.2	22.6	25.0	27.2	0.5
		SD						SD	3.03	3.65	8.51	5.94	
		ratio	NA	0.87	0.65	1.34	0.83	ratio	NA	0.97	1.08	1.17	
	-	Mean	21.0	16.0	26.5	21.0	20.5	Mean	22.8	21.0	24.0	25.6	
		SD						SD	4.32	4.18	5.05	3.05	
		ratio	NA	0.76	1.26	1.00	0.98	ratio	NA	0.92	0.36	1.12	
Dist. II	+	Mean	23.0	22.0	31.5	24.0	27.0	Mean	23.2	25.8	29.0	19.6	3.4
		SD						SD	3.03	6.22	9.43	4.34	
		ratio	NA	0.96	1.40	1.04	1.17	ratio	NA	1.11	1.25	0.84	
	-	Mean	21.0	24.0	24.5	23.5	25.0	Mean	22.8	19.0	26.8	19.6	
		SD						SD	4.32	4.30	1.30	5.41	
		ratio	NA	1.14	1.17	1.12	1.19	ratio	NA	0.83	1.18	0.86	